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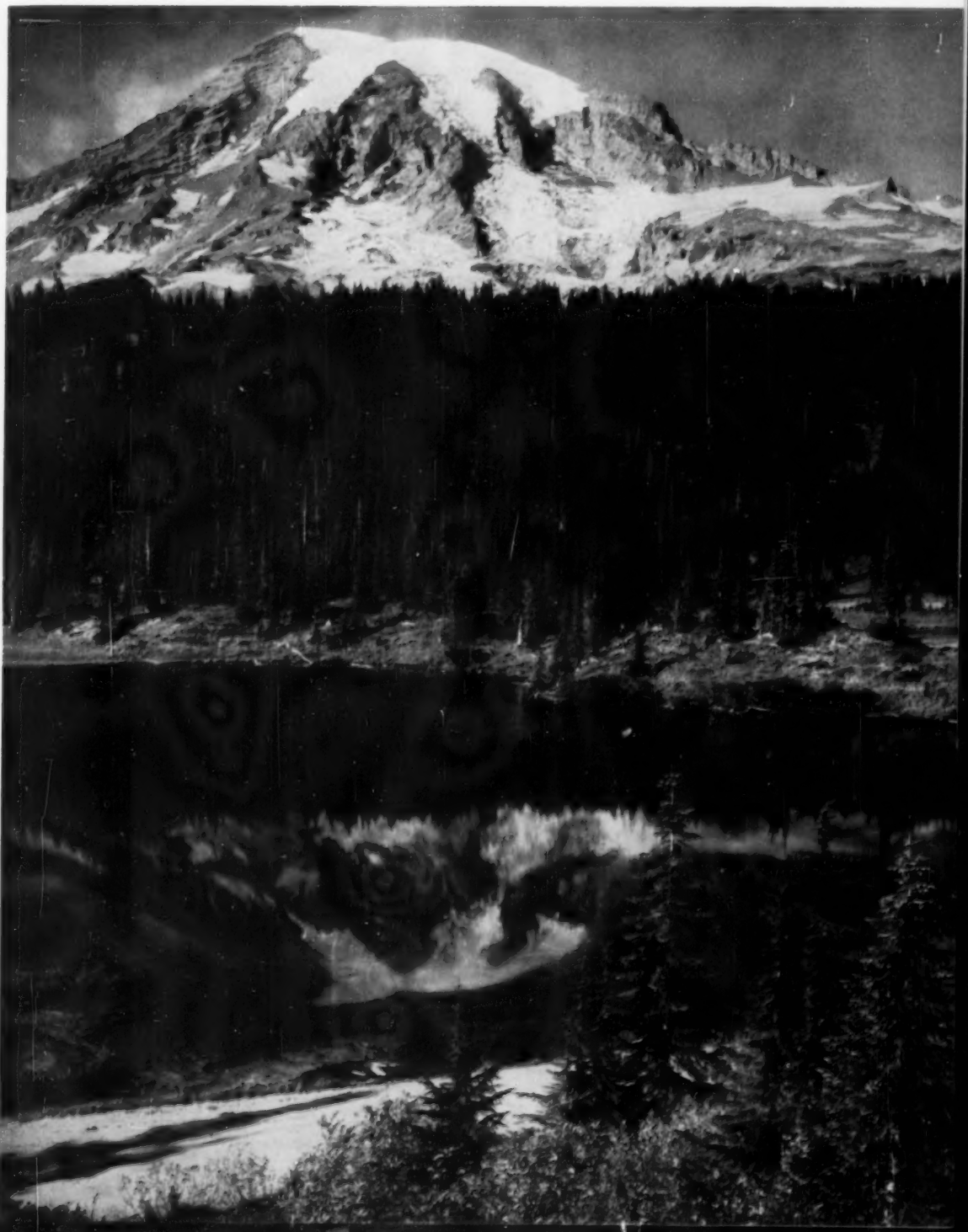

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Photo courtesy West Coast Lumberman's Assn.

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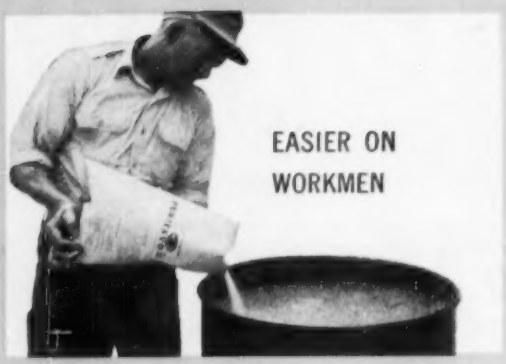

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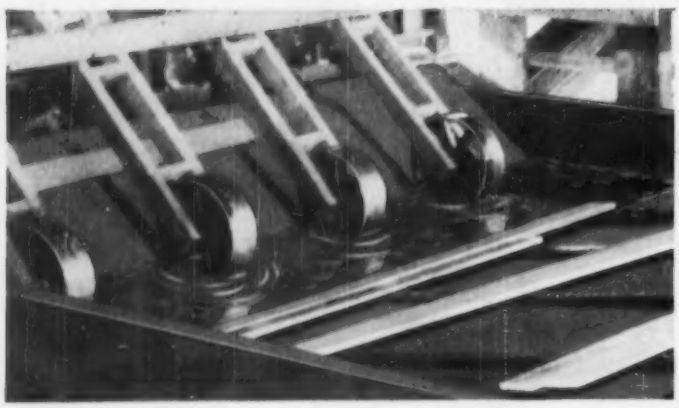

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Factors Affecting Productivity of Some Lands in the Willamette Basin of Oregon for Douglas-Fir Timber

Paul E. Lemmon[1]

Forestry specialist, Soil Conservation Service, U. S. Department of Agriculture, Portland, Oregon

PRODUCTIVE CAPACITY is one of the most important limitations on the use of land. Erosion is a vitally important hazard to that capacity. In order to inventory the land resources properly, one must know something about the factors that regulate productive capacity and cause vulnerability to erosion. This information is also needed in order to properly classify the land and to help develop and apply corrective land-use treatments.

The Soil Conservation Service began studies in Washington as early as 1944 to develop and test methods and procedures for obtaining information about the productive capacity of land for timber (*16, 20*). Correlations between production and the land-mapping units used in the areas by the SCS were obtained. This kind of work is being extended to other areas and to other species. The present report includes a study, started during the winter of 1951-52, of the productive capacity of lands in the Willamette Valley of northwestern Oregon for Douglas-fir timber.

[1]Recognition is hereby given to J. Melvin Williams, soil survey supervisor, and a number of soil scientists working under his technical direction (Harold W. Biggerstaff, Clarence R. Olds, William P. Badurina, Ralph B. Cleveland). These men were responsible for the collection and interpretation of all soils information. Planning and coordinating the work was facilitated and made possible by William W. Hill, state soil scientist, Samuel L. Sloan and Robert L. Brown, formerly Oregon state conservationist, and assistant, respectively; Stanley W. Cosby, regional chief, conservation surveys division; Theodore B. Plair, formerly regional chief of Forestry Division; and William R. Van Dersal, formerly regional chief of Operations, all of the U. S. Soil Conservation Service.

Recognition is also given to Dr. T. S. Coile, Professor of Forestry, Duke University, who reviewed the manuscript and made many helpful criticisms and suggestions.

Literature Review

Much interest has been shown recently in studies of timber site quality and in methods of predicting, from basic factors of the environment, the productive capacity of the land for timber. Direct measurements of forest production on a site that is thought to be best suited to timber production is not always possible, because a suitable stand for measurement may not exist. Methods have therefore been sought to make possible a sufficiently accurate estimation of productive capacity by reference to certain permanent factors of the environment that are easily measurable and mappable. This can often be done by relatively simple casual examinations. In other cases, highly developed mathematical methods of analysis are required for a full understanding of the interacting relationships. A considerable background of literature is building up on this subject. A current review shows efforts have been made to determine correlations between tree growth of many species and some of the most important elements of each of the four major habitat factors (climatic, physiographic, biotic, and edaphic). Brief reference to these studies follows:

Climate as a factor affecting tree growth has always been recognized by students of timber-site quality. It usually is considered by limiting studies of site quality to areas or zones of more or less homogeneous climatic influences. Some authors, however, have segregated elements of the climate, such as total annual precipitation, seasonal precipitation, latitudinal variations, temperatures, etc., and have studied the effects of these factors on site quality (*16, 20, 29, 33*). These factors are confounded with many other habitat factors affecting plant growth, and a thorough statistical interpretation of the effects of individual items of climate is not worked out. Climate alone has not been found satisfactory for the purpose of predicting site quality for timber.

Almost all students of timber-site quality have recognized physiographic features as important factors affecting plant growth. Usually, such specific factors as slope gradient, position on the slope, aspect or exposure, and elevation have been used as classified items for consideration (*1, 2, 6, 8, 12, 20, 23, 35*). These factors of the habitat are also confounded with many others in their effects on timber growth. Information obtained about them has been rather indefinite and general. Einspahr and McComb (*12*) made one of the best statistical studies of some of these factors in an effort to determine the individual effects of each on tree growth. Much still needs to be known before a full and accurate understanding of the individual and combined effects of these physiographic factors is obtained. At best they promise to be only minor clues in predicting site quality.

A few authors have investigated the effects of such biotic factors as turpentining, stand density, and plantings outside of a species' natural zone as factors influencing site index (*15, 22, 29*). Such factors have not been used to any great extent as clues for predicting site quality. It is essential, however, to be aware of their possible influences when working out correlations with other habitat factors.

Ground or understory vegetation is an additional biotic factor studied as a clue to forest productivity. Coile (*6*) presents background information for and against the use of ground vegetation instead of measurement of forest growth to indicate site quality. He (*10*) also presents evidence that correlations exist between the growth of most understory vegetation and the same habitat factors that correlate with production of the overstory. Lunt (*23*), Turner (*35*) and many other authors have also given attention to ground or understory vegetation as a clue to timber site quality. Generally, the use of understory or ground vegetation alone in predicting productive capacity of a site for timber is less satisfactory than where other factors of the environment are used in correlation.

A number of authors have reported efforts to correlate timber production with recognized soil series and types (*5, 8, 12, 18, 20, 23, 33, 35, 37*). Chandler et al. (*5*) and Einspahr and McComb (*12*) found satisfactory correlations. Haig (*18*) and Lunt (*23*) could find none, while other authors found varying degrees of correlation to exist among certain groups of soil series and types. Land-use capability classes, used by the SCS, did not correlate with productive capacity for timber, according to Hill et al. (*20*).

Auten (*2, 3*), Haig (*18*), Storie and Wieslander (*33*), and Tarrant (*34*) are among the recent authors reporting studies of forest growth as influenced by chemical properties of the soil. These properties include the amount of available nitrogen, phosphorus, calcium, magnesium, potassium, organic matter content, general nutrient level and reaction pH. All except Storie and Wieslander indicated that no significant direct correlations were obtained. The latter mention chemical properties of the soil, such as alkalinity and salinity, as being important items in determining productive capacity of different sites for timber.

Most recent authors reporting studies aimed at predicting site quality have based their correlations on physical properties of the soil as primary factors. They also have included some of the other habitat factors mentioned above as more or less incidental (*1, 7, 10, 11, 13, 14, 16, 19*). Some of the physical properties measured and used in the correlations are texture, permeability, thickness, plasticity and water holding capacity of the several horizons; color, compactness, drainage (or lack of it), silt-plus-clay content, colloidal content, imbibitional water values, weight-volume relationships, total effective depth, content of gravel, capillary and noncapillary pore space, and moisture equivalent. Varying degrees of success have been obtained in arriving at significant correlations. Very high order correlations have been obtained with some factors in some cases, whereas elsewhere these same factors failed to show significant effects.

Several authors have implied directly or indirectly, and the present author believes, that productive capacity of a site for timber is related quite definitely to factors which provide optimum amounts of available moisture for plant growth during the longest period in the growing season (*1, 9, 11, 20, 27, 35*).

This literature review helps illustrate the complexities of the problem. It indicates the improbability of finding a simple solution which will work throughout the country for predicting site quality without the presence of a suitable stand of timber for measurement. It shows the need for different studies applicable to specified zones or areas and individual species in which satisfactory correlations are developed between timber growth and some specific, easily recognizable, measurable and mappable factor or factors.

Methods

This study was limited to the more or less homogeneous climatic zone of the Willamette Basin of northwestern Oregon. The results are immediately applicable to land below an elevation of 2,000 feet. One tree species was included Douglas-fir (*17*), the most important timber producing species in the area.

Measurements of forest production were made in 310 existing, unmanaged, even-aged forests of normal stocking and condition. The stands varied in age between 20 and 207 years, with the average being somewhere between 45 and 55 years. Average total height, in relation to average total age of dominant and codominant trees in these stands, was accepted as the most usable guide for measuring productivity. This relationship at 100 years of age is known as the site index for Douglas-fir. Yield tables for different site-index classes have been developed and are in general use (*24*). Average total height and age of these stands were based on measurements by standard methods (*25*). From 5 to 10 dominant and codominant trees were measured in each forest. Supporting general information was recorded on such things as are taken into account in deciding whether or not a forest is unmanaged, normally stocked, and in normal growing condition (*24*). Information about ground and understory vegetation was also recorded.

Measurement of land and climatic factors for correlation were made concurrently with those of forest production. They include three classes of habitat factors, soil (edaphic), topography (physiographic), and climate (climatic).

Soils were examined with an auger or pit, or both, to obtain accurate representative information for each plot (*32*). Total effective depth in inches was measured to a total of 60 inches or to the limit of satisfactory root and moisture penetration, whichever was reached first. Depth in inches to the bottom of each layer thought to have significantly different permeability was also determined and recorded. Textural class was determined for each layer by field methods, wetting and rubbing between the fingers. This information was recorded and the texture of the surface soil given a generalized group symbol in addition. Permeability of each layer beneath the top soil

was determined through field inspection by an experienced soil scientist and each layer assigned to a permeability class (*26, 36*). Kind of underlying material was determined and indicated by symbol. Soil series as described in published reports was noted for each plot (*28*).[2] Presence of stones or gravel in the top soil sufficient to modify the texture or management was recorded. General information about structure, color, mottling, presence of roots, etc., was recorded and sometimes diagrammed to assist in interpretation. Soil examination and measurements were of the type used as standard by the SCS. A little more detail—such as indicating actual depths in inches instead of indicating depth groups—was included, however. All information was coded as far as possible in accordance with national standards (*32*).

Topographic features for each plot were recorded: average slope in percent, aspect in degrees azimuth, position on the slope, and elevation.

Aspect was taken as the average perpendicular direction away from the slope in degrees azimuth. Magnetic declination of the compasses was set off at 22 degrees. In the case of ridge top positions, the aspect was read down the ridge. Aspect was not deemed important in establishing the site quality in some locations and they were designated as "X." Usually, these locations were on slopes of less than 3 percent.

Position on the slope was recorded under one of four classes: "X," which occurred on almost level land and accompanied an "X" designation for aspect; "L," representing lower slopes, bottom or valley areas — where hills or mountains in the immediate vicinity may significantly influence tree growth by affecting climate or moisture relationships within the soil; "M," representing midslope positions; and "U," representing upper slopes and ridge tops, where topography may influence tree growth significantly through wind action and indirect effects. The approximate length of slope, as indicated by casual observations from the plot area, was recorded to help determine validity of the position effect. Elevation was recorded by means of a surveyor's barometer or by using available topographic maps.

Climatic factors were partially controlled because the study was confined to a generally homogeneous area. Elevational influences might be reflected as climate, so this factor was measured for each plot. Seasonal influences and cycles are averaged when long-lived perennial plants are studied. The average total annual precipitation and the average seasonal precipitation (6 months period from April through September) were recorded for each plot by reference to isohyetal maps.[3]

All information, including the specific location of each forest studied, was accumulated on especially designed cards. Continuous checking of results as the field work progressed often pointed out discrepancies in the data. This called for rechecking some of the locations, during which many of the apparent variations were explained on the basis of facts not originally picked up. All field work was done by experienced soils technicians and foresters, usually working as a team.

All plots (forests) studied, classified into major groups A and B and into soil series, are summarized in Table 1. Rejected plots are also shown.

Analyses.—Residual hill soils in group A and the Powell Series in group B (Table 1) were investigated by regression analyses. The average total height of dominant and codominant trees was used as the dependent variable indicative of site quality. Average age and certain measured land and climatic factors were used as independent variables (Table 2). Preliminary study of selected plots indicated that linearity existed between the different independent variables which were used and the logarithm of average tree height. Consequently, the fundamental growth curve proposed by Schumacher (*30*) and employed by Ralston (*29*) and others was used.

Aspects were classified into "north," "south," and "level," and were analyzed separately or in combination. North aspects included plots whose azimuth read

[2] Soil series referred to in this paper are currently being refined for the Willamette Valley. It appears that from one to several new series may be broken out of each series now used.

[3] Map showing warm-season precipitation for Oregon was taken from Climate and Man, U. S. Dept. Agric. Yearbook, 1941 and superimposed to scale over an isohyetal map of total annual precipitation in the Willamette Basin. The latter was provided by the Corps of Engineers, U. S. Army, Office of the District Engineer, Portland, Oregon.

TABLE 1.—SUMMARY OF ALL PLOTS STUDIED

Total number of plots studied		310
Total number of plots rejected:		
After field checking	19[1]	
Results questionable but field checking not completed	13	
	32	32
Total number of plots used in analyses		278
Distribution of plots among the different soil series:		
A. Residual hill soil series of major importance in continued forest production.		
Olympic	118	
Melbourne	34	
Aiken	14	
Cascade	12	
Polk	3	
Total	181	
B. Other soil series: where other potential use is greater than for forest production; where conditions are very poor for forest production; or on soils of such small extent in the valley as to be relatively unimportant in forest production.		
Amity	5	
Camas	10	
Carlton	2	
Chehalis	4	
Clackamas	1	
Hillsboro	5	
Newberg	4	
Powell	28	
Salem	16	
Salkum	3	
Viola	1	
Willamette	18	
Total	97	

[1] These 19 plots were rejected for any one of several reasons such as snow, ice, insect, or fire injury.

TABLE 2.—SUMMARY OF REGRESSION ANALYSES USING LOGARITHM OF THE AVERAGE TOTAL HEIGHT OF DOMINANT AND CODOMINANT TREES AS THE DEPENDENT VARIABLE

Analysis number and description[1]	No. of plots	Item[2]	Independent variables studied: Reciprocal of age X_1	Soil depth X_2	Slope percent X_3	Elevation feet X_4	Total precipitation Annual X_5	Total precipitation Warm season X_6
Residual hill soils including Olympic, Melbourne, Aiken, Cascade, and Polk								
1. North aspect with soils 60″ and over	23	by's	−13.539,482	not used	+ .000,514	− .000,014	+ .000,778	+ .011,772
		t	9.093,241**	not used	.580,790	.500,000	.979,848	1.019,838
2. North aspects with soil 60″ and under	21	by's	−11.494,441	+ .003,452	− .000,320	+ .000,019	− .000,725	+ .004,217
		t	5.835,950**	2.407,252	.501,567	.678,571	.713,582	.403,579
3. North and level aspects with soils of all depths	71	by's	−13.320,182	+ .001,986	− .000,137	+ .000,008	+ .000,286	+ .000,219
		t	16.064,360**	3.098,284**	.318,605	.533,333	.639,821	.110,998
4. South aspects with soils 60″ and over	32	by's	−13.213,100	not used	− .000,330	+ .000,022	+ .000,703	− .004,927
		t	9.142,311**	not used	.626,804	.728,960	.756,052	1.627,152
5. South aspects with soil 60″ and under	40	by's	−12.037,842	+ .003,630	− .000,146	− .000,027	+ .000,545	− .003,041
		t	10.234,615**	4.442,720**	.514,227	1.386,963	.665,446	1.107,034
6. South and level aspects with soils of all depths	99	by's	−14.112.199	+ .002,165	− .000,362	− .000,025	+ .000,821	− .001,455
		t	21.782,286**	4.147,509**	1.925,531*	2.272,727**	2.073,232**	1.173,387
Powell soil series								
7. All aspects and all soil depths	28	by's	−12.120,703	+ .002,160	+ .000,087	− .000,029	not used	not used
		t	8.369,790**	4.770,329**	.211,124	.773,643	not used	not used

[1]Analysis No. 3 includes the plots used in both analysis No. 1 and No. 2 and another set of plots with level aspects where the slope was generally below 3%.
Analysis No. 6 includes plots in both analysis No. 4 and No. 5 and the same set of level plots that was used in analysis No. 3.
[2]by's—partial regression coefficients. t—values for determining statistical significance.
*Significant above the 5% level. **Highly significant above the 1% level.

from 331 to 120 degrees inclusive. South aspects covered azimuth readings from 121 to 330 degrees. Level aspects were found on slopes of less than about 3 percent, which rendered the aspect variable non-effective.

Surface soils of all but one of the plots on residual hill soils, and all of the plots on the Powell Series, were classed as medium-textured. Surface texture, therefore, was ignored as a variable in the analyses.

Only those plots indicated as having midslope positions were included in regression analyses. Positions indicated as "X" were considered as midslope positions of level aspect. Thirty-seven plots having upper- or lower-slope positions were not included in the analyses and are not reported.

Soil depth, as a variable, was held at 60 inches for all plots of this depth and over, whereas the actual numerical values of soil depth were used for plots having lesser depth.

Miscellaneous soils in group B (Table 1) except for the Powell, were studied in different ways depending upon the characteristics. They are classified in this report by soil mapping units used by the SCS, which fairly well define the soil series. Where sufficient data are available, they have been arranged into depth groups and a simple arithmetic average of site index from published growth curves (*24*) is presented. This represents a satisfactory correlation between site quality and permanent mappable land factors. The parameters of these measurements were measured by calculating the coefficients of variability. This method was found to be very satisfactory by Gessel and Lloyd (*16*) and Hill et al. (*20*).

All statistical work followed Snedecor (*31*).

Results

Residual hill soils and the Powell Soil Series.—Multiple regression analyses were made of these two groups of soils according to standard methods. The former group represents the most important soils in the Willamette Valley for permanent forest production. Although 10 soil series have been recognized, named and published in this group (*28*), only 5 were included among the plots measured (Table 1). They are Olympic, Aiken, Melbourne, Cascade, and Polk, which comprise practically all of the soils in the group where drainage is considered good. The first four are the most important series from the standpoint of total land area. The Powell Soil Series was the only one in the miscellaneous group (Table 1) where enough samples existed to permit regression analyses.

The analyses made, variables employed, coefficients obtained and their levels of significance are summarized in Table 2. Where variables did not prove to be significant above the 5 percent level, they were eliminated. Note that for north and level aspects on residual hill soils and for the Powell Soils, only total effective soil depth proved to be a significant indicator of site quality. On south and level aspects on the residual hill soils a number of factors (soil depth, slope, elevation, total annual precipitation) proved to be significant.

The best estimation of site index for north and level aspects on medium-textured residual hill soils with midslope or unimportant positions is thought to be expressed by Equation No. 1 (p. 327) derived from analysis No. 3 (Table 2).

For south and level aspects in this same group of soils, the best estimation of site index is thought to be expressed by Equation No. 2 (p. 327) derived from analysis No. 6.

Equation No. 1: $Y = 2.196{,}535 - 13.379{,}077\ X_1 + 0.002\ X_2$

Equation No. 2: $Y = 2.185{,}764 - 13.881{,}570\ X_1 + 0.002{,}189\ X_2 - 0.000{,}344\ X_3 - 0.000{,}023\ X_4 + 0.000{,}604\ X_5$

Equation No. 3: $Y = 2.173{,}986 - 12.241{,}256\ X_1 + 0.002{,}115\ X_2$

For the Powell Soil Series of medium-texture, including all aspects and positions, the best estimation of site index is thought to be expressed by Equation No. 3 (above) derived from analysis No. 7.

In these equations X_1 is the reciprocal of age, X_2 is the total effective soil depth in inches, X_3 is the slope in percent, X_4 is the elevation in feet, X_5 is the total annual precipitation in inches and Y is the logarithm of the estimated tree height. The multiple correlation coefficients (R) of these equations are 0.8991, 0.9335, and 0.8841 respectively. This indicates that a very high degree of success is attained by using the equation to estimate the site index of any comparable area.

When age is held at 100 years these equations render the site index directly.

By the use of these equations, it is possible to calculate the effect of any one variable on site index with all other variables controlled. This has been done with all variables held at the mean (Table 3) except age, which was held at 100 years, and the information is partially shown in figures. Fiducial limits at the 5 percent level were also calculated and are shown.

Estimated site index on residual hill soils for south and level aspects as influenced by total effective soil depth is shown in Figure 1. It was obtained by solving for Y in equation No. 2. The broken parts of the curve are extensions beyond the limits of the data and are included only as a matter of interest. Almost identical curves are obtained for north and level aspects on residual hill soils and for the Powell soils when solving for Y in equations Nos. 1 and 3. A slight upward trend is shown as the total effective soil depths increase from 18 to 60 inches. This indicates almost equal effectiveness of soil at different depths in affecting site index. This information may be helpful in establishing soil depth groups for soil mapping.

Estimated site index on residual hill soils for south and level aspects as influenced by slope is shown in Figure 2, by elevation in Figure 3, and by total annual precipitation in Figure 4. These have all been derived by solving for Y in equation No. 2. The slope relationship is negative and linear. It's total effect over the range from 5 to 130 percent amounts to 13.8 site index points which is about the value of the average fiducial range. This effect is hardly sufficient to justify the establishment of slope groups in soil surveying to reflect differences in production. Slope groups in the conservation survey should not be thought of as reflecting limitations in production alone, but rather, to indicate hazards under continued use and other limitations in forest management. Elevation effect is negative and linear whereas the effect of total annual precipitation is positive and linear. Both factors should be considered in forest management.

Tests for significance.—Besides those shown in Table 2, tests were made to determine significance between comparable regression coefficients derived from analyses 1 and 4, 2 and 5, 3 and 6, 3 and 7, and 6 and 7. No significant differences were found, and it is assumed that there is no significant difference between estimations of site index from either of the three equations presented. Including the same group of level plots in analyses 3 and 6 may have masked somewhat the effect of aspect, which is reflected in a comparison between equations No. 1 and No. 2. When curves derived from equations 1, 2 and 3 showing effects of soil depth on site index are superimposed, they fall within an area common to the confidence bands of all three. This indicates that the most reliable regression could have been obtained by ignoring aspect and combining the plots in analyses 1, 2, 4, 5, 7,

TABLE 3.—MAXIMUM, MINIMUM, AND MEAN VALUES OF VARIABLES USED IN REGRESSION ANALYSES SHOWN IN TABLE 2

Variables		Analysis number[1] 3	6	7
X_1, average tree age, years	Maximum	91	207	58
	Minimum	30	28	20
	Mean	49	52	44
X_2, total effective soil depth, inches	Maximum	60+	60+	60+
	Minimum	22	18	20
	Mean	50	48	41
X_3, slope, percent	Maximum	64	136	45
	Minimum	0	0	2
	Mean	17	22	21
X_4, elevation, feet	Maximum	1,760	2,700	900
	Minimum	250	325	240
	Mean	793	927	553
X_5, average annual precipitation, inches	Maximum	88	106	67
	Minimum	37	39	43
	Mean	59	64	51
X_6, average warm-season precipitation, inches	Maximum	19	19	16
	Minimum	6	6	10
	Mean	11	11	13
Y, average tree height, feet	Maximum	161	155	128
	Minimum	60	60	62
	Mean	95	102	95

[1]Equation Nos. 1, 2, and 3 were derived from analyses Nos. 3, 6, and 7, respectively.

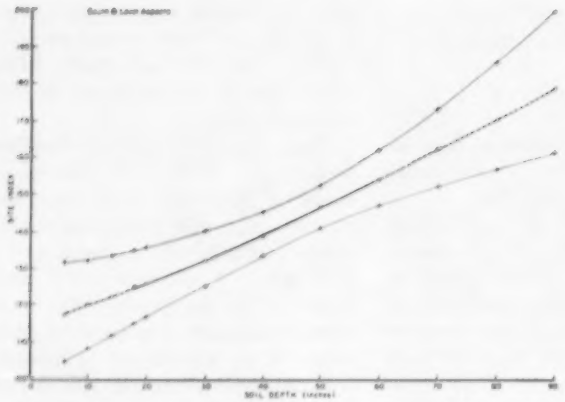

FIG. 1.—Site index on south and level aspects as influenced by total effective depth of soil. Residual hill soils of medium surface-texture.

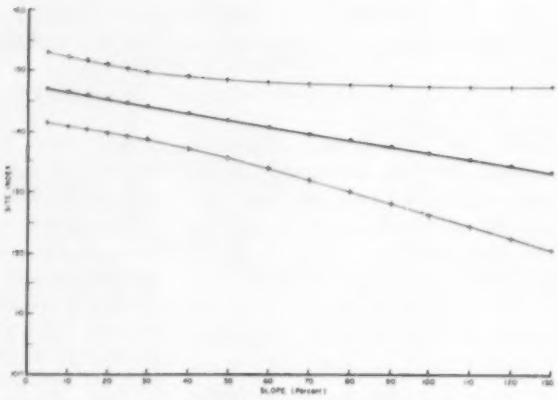

FIG. 2.—Site index on south and level aspects as influenced by slope. Residual hill soils of medium surface-texture.

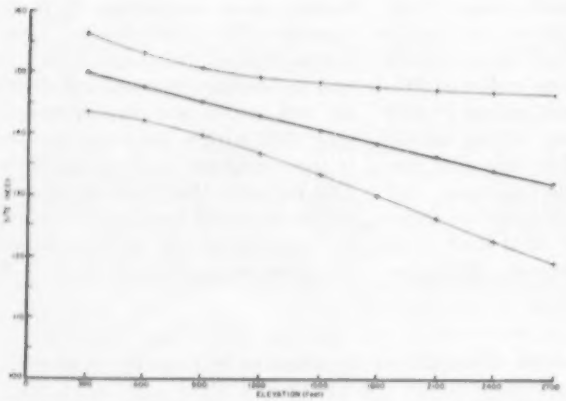

FIG. 3.—Site index on south and level aspects as influenced by elevation. Residual hill soils of medium surface-texture.

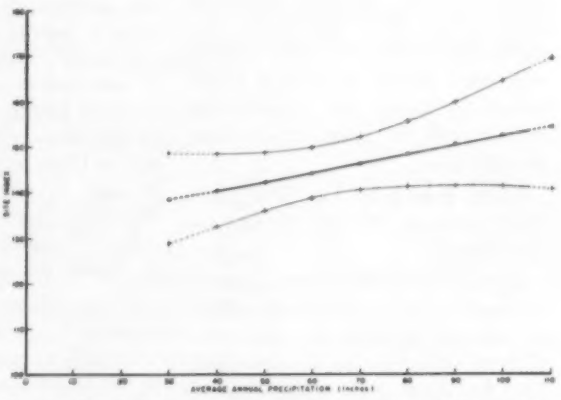

FIG. 4.—Site index on south and level aspects as influenced by total annual precipitation. Residual hill soils of medium surface-texture.

and the level plots common to analyses 3 and 6.

Application.—Rather than recalculate the coefficient as suggested above, a weighted average curve (Fig. 5) was obtained from the calculated values obtained by solving equations 1, 2, and 3. The fiducial bands for estimating site index from a single plot at the 5 percent level were calculated for each of the 3 equations. The new variances for different increments of soil depth were then weighted on the basis of the degrees of freedom involved and a weighted average variance calculated. This was used as a basis for obtaining weighted average fiducial bands in Figure 5. Figure 5 may now be used for estimating site index from a single plot on the basis of total effective soil depth alone. It applies generally to an area in the Willamette basin below about 2,000 feet in elevation on medium-textured residual hill and Powell soils of any slope, aspect, elevation or precipitation. It will give accuracies of about ± 22 site index points for soil depths between 20 inches and 60 inches at about the 5 percent level. The broken portion of the curve (below 20 and above 60 inches) are extensions beyond the limits of the data and are shown only as a matter of interest to stimulate further investigation.

Miscellaneous soils.—There are many more recognizable soils in the Willamette Valley than those represented by the three equations given above. Many of these were originally forested. Some of them are in forest cover today. From the standpoint of total forest production in the future, however, they are relatively unimportant because either the acreage is small, the soils are of low site value for timber, or they have greater potential uses than for forest production. A number of plots were measured on some of these miscellaneous soils and the information is summarized in Table 4. To get usable information about their productive capacity for Douglas-fir, this miscellaneous group was classified by soil series and depth groups. Mapping units included in each group are shown. The site indexes for the plots were averaged within these groups and,

where enough measurements were available, the coefficient of variation was calculated to give an idea of the range which existed among the measurements. This information may be used directly for estimating productive capacity of these soils for Douglas-fir.

Summary

Landowners and technicians need a reliable method of estimating the productive capacity of land for timber irrespective of the present plant cover. A generalized summary of pertinent literature indicates the progress to date in devising such a method and in converting it into practical use. It is obvious that no universally applicable simple method is possible, but through a knowledge of basic factors the information can be worked out satisfactorily for more or less homogeneous climatic zones. To help meet this need in the Willamette Valley of northwestern Oregon, site quality for Douglas-fir was studied in relation to land and climatic factors on 310 selected plots representing even-aged, normally stocked, unmanaged stands.

Productive capacity for timber was obtained in the usual manner by determining average total age and total height of the dominant and codominant trees on each plot. Land and climatic factors studied concurrently were: total effective soil depth, textural class of the surface and subsequent soil layers, relative permeability class of each soil layer, kind of underlying material, percent slope, aspect, position, drainage, elevation, total annual and total warm-season precipitation. These factors are considered to be easily recognizable, measurable and mappable by standard field methods ordinarily used in a soil survey or are available from some other convenient source.

Plots were allocated to three groups for summary and analyses: (1) Residual hill soils including Olympic, Melbourne, Aiken, Cascade and Polk series. These were further separated into north, south and level aspects. (2) The Powell soil series. (3) Other miscellaneous soils potentially less important in future permanent forest production than group 1 and 2. The first two classes were studied by multiple regression analyses the third by classification into soil series and depth groups. The studies have resulted in the development of three regression equations which may be used to estimate site index for land represented by groups 1 and 2 above. A summary table, giving average site indexes and coefficients of variation, is included for some of the miscellaneous soils in group 3.

The regression equations to be used in determining site quality are given for residual hill soils including both *north* and level aspects; for residual hill soils, including both *south* and level aspects; and for the Powell soil series including all aspects.

By the use of these equations, each significant variable tested was studied with respect to its effects on site index independent of all others. Tables, figures, and discussions of these studies are presented.

A generalized curve has been developed by which site index can be estimated readily for the Willamette Basin from information

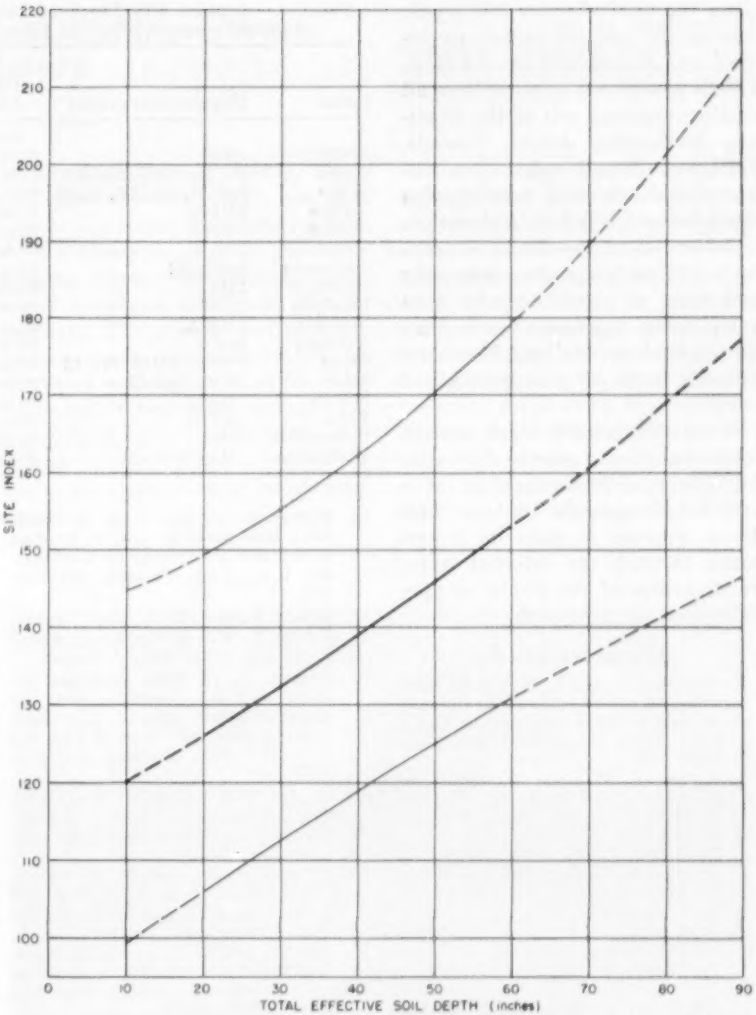

FIG. 5.—Average site index for Douglas-fir as influenced by total effective soil depth. Applicable between soil depths of 20 to 60 inches in the Willamette Basin below about 2,000 feet in elevation on medium textured, well drained, residual hill and Powell soils of any slope, aspect, or precipitation. Fiducial limits at the 5 percent level are shown for estimating site index from a single plot.

about the total effective soil depth, between 20 and 60 inches, as defined and determined by the SCS. This is considered applicable to all medium-textured soil of the Olympic, Melbourne, Aiken, Cascade, Polk, and Powell series of all aspects, positions and precipitation zones below 2,000 feet in elevation. Calculations of the limits of accuracy with each equation separately and tests of significance between comparable regression coefficients in the various analyses have provided a basis for this generalized curve.

Total effective soil depth was the most important factor in determining the productive capacity of a site for Douglas-fir timber. This factor appears to gain its importance through the internal water relationships of the profile as they influence plant growth.

TABLE 4.—AVERAGE SITE INDEX OF DOUGLAS-FIR ON MISCELLANEOUS SOILS OF DIFFERENT SERIES, MAPPING UNIT DESIGNATIONS, AND DEPTH GROUPS

Series	Mapping unit symbol	Depth limits	No. of plots	Site index average	Standard deviation	Variation coefficient
		Inches				*Percent*
Amity	1M23	60 or more	5	142	13	9
Camas	2M5X, 2M5Z, 2M5XZ	36 to 60	4	164	19	12
Camas	3gM5Z, 3M5XZ, 3M5Z	20 to 36	6	154	17	11
Carlton	2M42S	36 to 60	1	150		
Carlton	3M32S	20 to 36	1	132		
Chehalis	1M5X	60 or more	4	154	14	9
Clackamas	1gM35Z2	60 or more	1	148		
Hillsboro	1M5	60 or more	3	149	7	4
Hillsboro	1M34	60 or more	2	173		
Newberg	1M57X	60 or more	3	174	12	7
Newberg	1L6	60 or more	1	140		
Salem	2M43Z, 2M4Z, 2vM4Z	36 to 60	9	138	15	11
Salem	3M4Z, 3gM4Z	20 to 36	7	124	16	13
Salkum	2M3Z2	36 to 60	3	149	6	4
Viola	3M21B	20 to 36	1	158		
Willamette	1M34	60 or more	7	138	6	4
Willamette	1M4, 1M54	60 or more	11	169	9	5

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Six Thinnings in a 56-Year-Old Pure White Pine Plantation at Biltmore

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The pioneer forest planting started by Dr. C. A. Schenck in the 1890's on the Vanderbilt Estate at Biltmore, near Asheville, N. C., was first reported in detail by Haasis (10) over 20 years ago. A progress report by Frothingham (9) in 1942 dealt with thinnings in both pure and mixed plantations of white pine. The present report on continued thinning in the pure stand (which is one of the oldest white pine plantations in the U. S.) covers the first six cuts. The present test is single and without replication, on an area totaling only one-half acre. It can never show how much may be cut currently without lowering the final harvest, but the advantage from thinning is becoming increasingly clear. Many of the prospective final crop trees reserved during the successive pulpwood harvests are now about to pass, or are already over the threshold of saw-log size. This marks the stage in which substantial benefits from thinnings begin to accrue.

EASTERN white pine, *Pinus strobus* L., is unquestionably one of the best of the Southern Appalachian species. From surveys in five of the mountain counties of Georgia and three of the southwestern ones in North Carolina, Barrett (*3*) showed a superiority in growth of white pine over yellow-poplar and all other associated species. Its current diameter increment averaged 3.5 inches in 10 years in these natural second-growth stands.

The preference for white pine planting stock on eroded slopes of the Biltmore Estate followed general failure of early work with many local hardwoods such as oak, sugar maple, and yellow-poplar. Of some 3,000 acres estimated to have been planted with all species between 1890 and 1914, about 500 acres of white pine plantations remain today. They have reestablished forest cover on many depleted hillside fields. Figure 1 shows how the site for the stand reported in this article appeared 2 years before planting in 1899. The pines were spaced closely, about 3 by 4 feet, to check erosion as promptly as possible. The consequent overstocking was first relieved in a quarter-acre experiment started in 1916.[1]

A commonly recognized advantage of thinning is accelerated diameter growth, which results in an increase in the number of large trees, and a consequent increase in early income (*11*). This permits a reduction of invested capital without sacrifice in growth capacity of a stand properly treated. There is reason to believe that the full productive power of a soil—its maximum capacity for wood production—can be maintained regardless of thinning. It appears that when

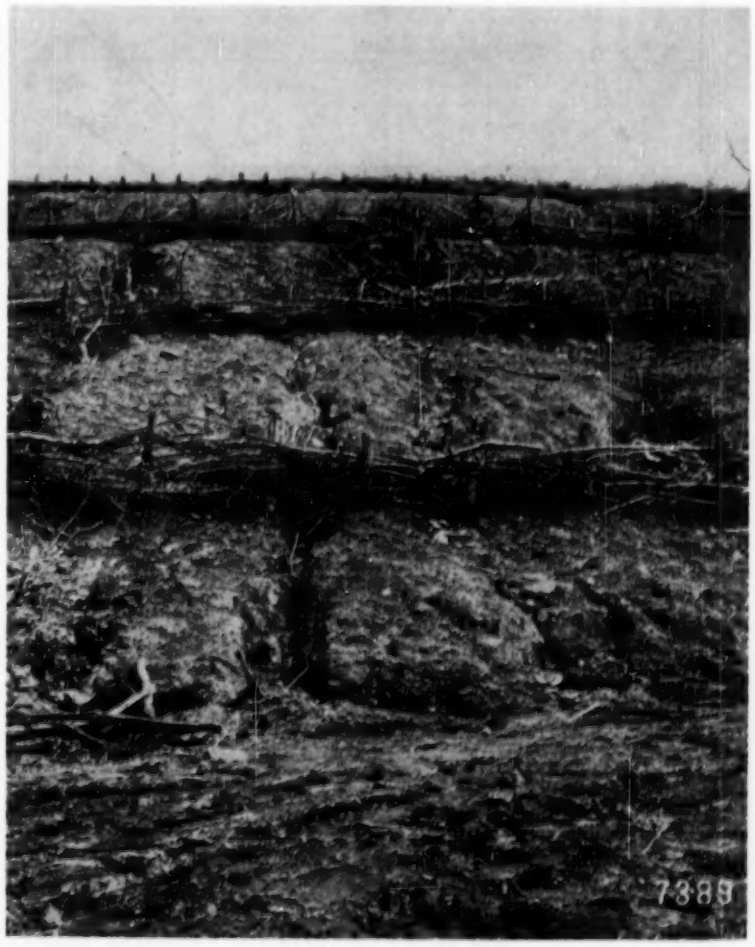


FIG. 1.—Eroded old-orchard planting site first protected by wattles and brush as it appeared in 1897, 2 years before it was planted with white pine by Dr. C. A. Schenck. The thinned stand reported in this article is located on this hillside.

[1]Noncommercial thinnings were not used, and large scale commercial thinnings were not made on the estate until 1946 (*17*).

thinning procedures avoid overcutting, the biological yield is not appreciably changed (*20*). That is, the actual increment plus thinnings on treated areas is much the same as net increment plus mortality on untreated areas. Most evidence of this so far has come from stands of pole-sized trees. For southern yellow pines, Bull (*4*) suggests that maximum pulpwood production in trees over 4 inches in d.b.h. and less than 60 years old can be had by thinning only enough to avoid loss through death of suppressed trees. For saw timber he recommends moderate thinning to avoid extremes of stand density and tree growth.

Increased growing space is an obvious, but not necessarily complete, explanation for the better growth of trees left in thinning. On worn-out fields there may be an improvement in soil conditions owing to the decomposition of the intermingled root systems of the trees removed. Early decay of mycorrhiza and the finer roots can promptly add to the supply of humus within the root zone. At the same time some injurious agents may be stimulated, as will be shown.

Disease and Insects

The white pine blister rust is not menacing here. In the Southern Appalachians, Ribes are seldom found below about 3,500 feet, whereas the Biltmore Estate and most other good white pine sites are below that elevation (*2*).

Another fungus, *Fomes annosus*, long recognized as a serious problem in Europe, and recently attacking red pine in the northeast, (*19*) is present on the Biltmore Estate. In southern Sweden this organism attacks roots of Scotch pine at 15 years, reaches a peak 20 years later and declines at about age 55. There it is found in undisturbed stands, but often advances after partial cutting (*15*). It does not appear to live in soil alone, but, as with some other butt-rot fungi, can spread from dead to living roots. At Biltmore the trouble has been traced to unnatural root arrangement from poor planting (*13*), but a build-up as a result of frequent thinning is evident. There is less of it in stands of natural origin, and less in the unthinned portions of plantations. Trees that die slowly in natural thinning apparently deplete the supply of soluble carbohydrates stored in the root system, thus leaving the dead roots a somewhat less favorable medium for fungus growth.

So far the damage to the thinned plot included in this study is minor. Ten out of 15 trees cut in the last thinning had butt rot, but decay affected only 0.233 square feet, or 0.4 percent of the stump basal area, and did not extend upward enough to affect the second pulpwood bolt. The extent of root damage was not determined.

Another minor trouble on the thinned plot also has been aggravated by the cutting. Exposed by thinning, the forest floor is probably dryer for a time, and the so called "leaf blight" tends to be worse near the open spots. It has been observed to reduce the growth of diseased trees about one-third (*7*). Control by spray is impractical, but spraying tests appear to have eliminated the likelihood of needle fungi as a cause of the trouble. Root aphids, *Prociphilus spp.* are suspected (*18*). This malady dictated the removal of some eight trees per acre in the sixth thinning, including one potential early crop

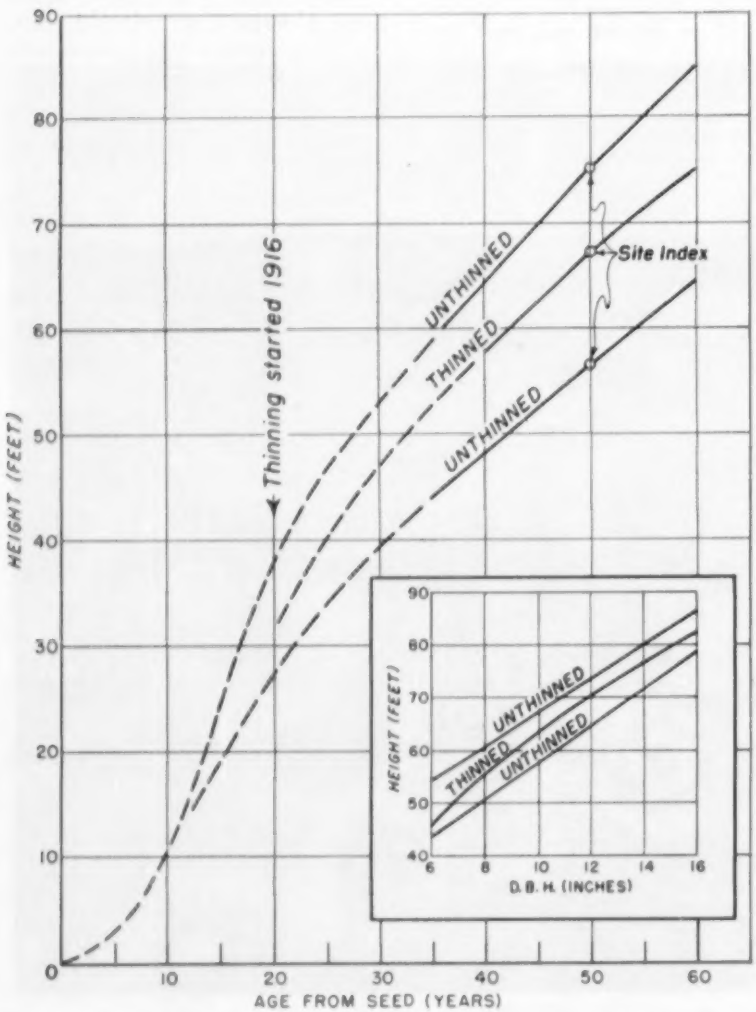


FIG. 2.—Site index curves and height-diameter relations (insert) for the thinned test plot and adjacent unthinned control plots.

tree. Damage remains insignificant because the wood was salvaged without interfering with full stocking.

Negligible also was the damage from another pest, the white pine weevil, *Pissodes strobi* Peck. So far no artificial control has been needed. If epidemics develop with an increase of pure stands, treatment with concentrated lead arsenate is suggested. Two sprayings can afford protection for 8 years and provide for a high percentage of well-formed logs (*6*).

Site Used

Seventeen years at close spacing without benefit of early thinning was not the only initial handicap. Accelerated erosion on the old orchard site had been severe before planting (Fig. 1). Time has healed the old scars, gradually rebuilding the forest floor under the pines, but without fully restoring the fertility of the virgin soil. At present the quality of the site for the thinned plot, index 67 lies between that of the two control plots, 56 and 75 feet at 50 years. The height of trees of a given diameter now averages 8 to 10 feet greater on one control plot than the other, with the thinned plot occupying an intermediate position (Fig. 2).

Type of Thinning

A series of six cuts opened the full canopy from below beginning at age 20. The thinnings removed a few trees of poor risk, many of slow growth as judged by crown ratio, and some others as needed to achieve more uniform spacing. This operation eliminated all natural mortality after the second cut. The portion of basal area removed, each time at intervals of about 6 years, varied irregularly between 10 and 24 percent of the total stand. The reserved basal area revolved around 100 square feet per acre, although initial cuts left somewhat less than this amount and later cuts somewhat more. The basal area in 1953

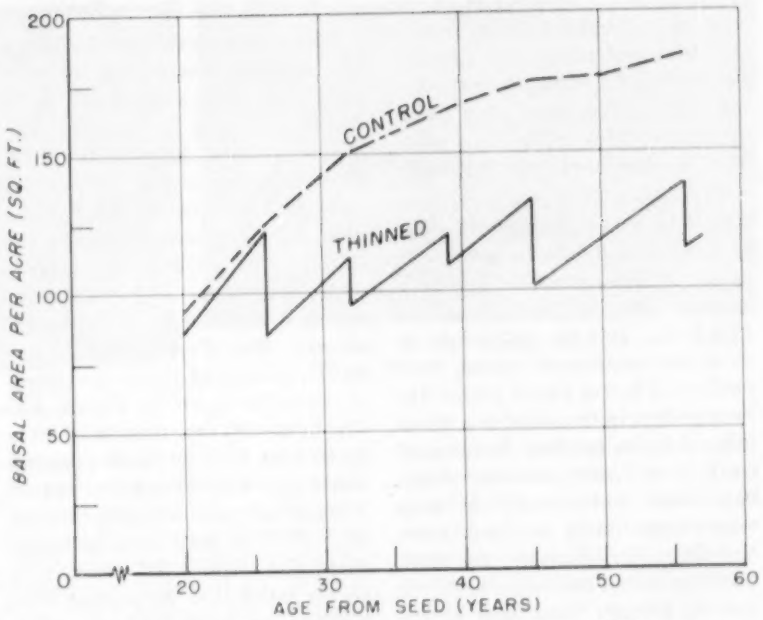


FIG. 3.—Basal area of white pine in relation to age during the last 36 years.

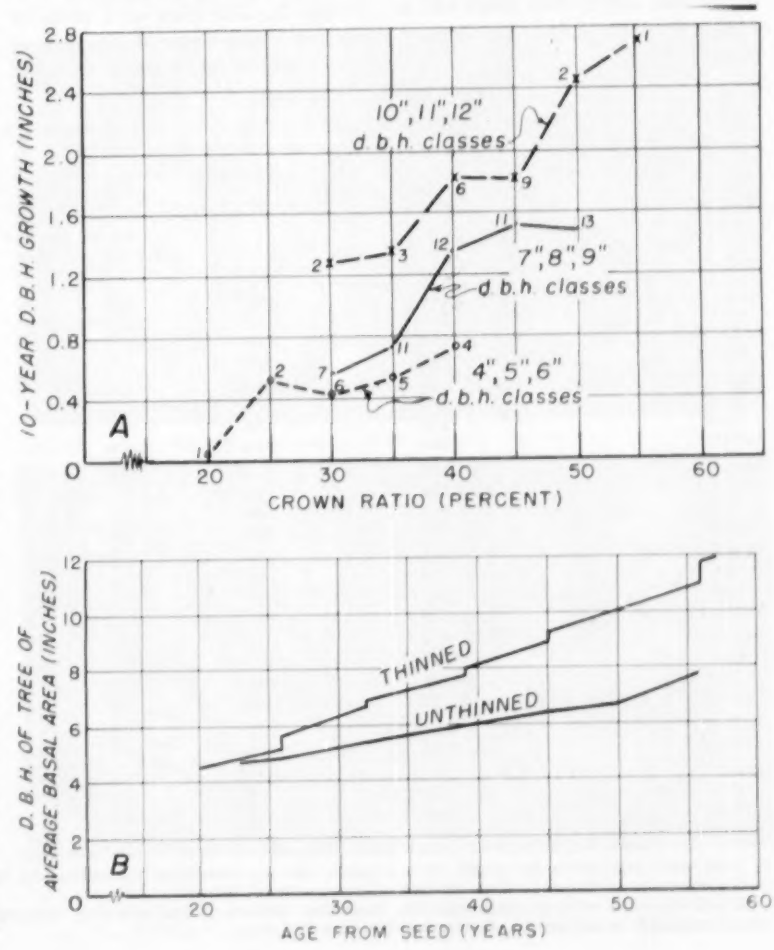


FIG. 4.—*A*, Effect of crown ratio on current rates of growth of three diameter groups of white pines, and *B*, effect of thinning in increasing the average size of trees during 36 years.

at age 56 is 115 square feet on the thinned plot and 184 square feet on the unthinned plots. The amounts removed and a contrast in the upward trend of basal area are shown in Figure 3. Most of the trees taken were necessarily of pulpwood size.

There were left on the uncut control plots at age 56 about 16 times as many pulpwood-size trees, with nearly 10 times as much basal area, as there were on the thinned plot (Table 1). But the pulpwood-size trees on unthinned plots were smaller—2 inches less in d.b.h.—the average tree in the stand as a whole being 4 inches smaller. Removal of small trees, after selecting dominants and codominants as crop trees, immediately increases average size. For example, the sixth thinning raised the diameter of the tree of average basal area by 0.8 inch. The last cut took trees about 50 percent larger than those which are currently dying on control plots.

Growth and Crown Ratio

Diameter growth after thinning was superior because the reserved trees were above average in size, in dominance, and in ratio of live crown to total height. In 1916, after thinning, crown ratios averaged 41.5 percent on the thinned plot and 34.3 percent on the unthinned. By 1953, these averages had dropped to 37.1 percent thinned and 29.2 percent unthinned. The effect of crown ratio on the growth of three size classes of trees is shown in Figure 4A. The trees with crown ratios of 20 to 30 percent were all small subdominants with very poor growth rates. For any given crown ratio between 30 and 40, growth rates increased with size class. All trees with crown ratios over 40 percent were medium or large, codominant or dominant, and growing well. Under-saw-log-size trees with 40 to 50 percent crown grew at the rate of 1 or 2 inches in 10 years. Similar crown lengths on saw-log trees resulted in diameter growth up to 2.4 inches in 10 years. In the absence of thinning, the crowded crowns on the smaller trees became progressively shorter. Reduced crown ratios together with subordinated position in the canopy and relatively smaller stems result in marked reduction of growth. On a 10-year basis, the growth in d.b.h. and in merchantable volume (per tree) declined with crown ratio as follows:

Live crown	Diameter growth	Volume growth
Percent	*Inches*	*Cu. ft.*
50	1.9	11.6
45	1.6	10.1
40	1.5	7.1
35	.9	4.8
30	.6	2.7
25	.5	0.8
20	.1	0.3

Growth from a crown ratio of less than 35 percent of total height is considered unsatisfactory.

Effects of Thinning

The immediate effects of thinning on average size of remaining trees

TABLE 1.—EFFECT OF SIX THINNINGS ON THE STAND, AVERAGE SIZE, AND BASAL AREA OF PLANTED WHITE PINE

Thinning	Age from seed	Trees per acre[1]			Average d.b.h.[2]			Basal area per acre		
		Pulpwood size	Sawtimber size	Both	Pulpwood size	Sawtimber size	Both	Pulpwood size	Sawtimber size	Both
No.	*Years*	*Number*			*Inches*			*Square feet*		
Stand	20	888	—	888	4.6	—	4.6	99.0	—	99.0
Cut 1		144[3]	—	144	4.2	—	4.2	14.0	—	14.0
Left		744	—	744	4.6	—	4.6	85.0	—	85.0
Control		828	—	828	4.6	—	4.6	92.3	—	92.3
Stand	26	828	—	828	5.2	—	5.2	123.1	—	123.1
Cut 2		352	—	352	4.5	—	4.5	38.9	—	38.9
Left		476	—	476	5.7	—	5.7	84.2	—	84.2
Control		936	—	936	4.9	—	4.9	124.6	—	124.6
Stand	32	460	20	480	6.4	10.0	6.7	102.3	10.9	113.2
Cut 3		112	4	116	5.1	10.1	5.4	16.0	2.2	18.2
Left		348	16	364	6.7	10.0	6.9	86.3	8.7	95.0
Control		924	4	928	5.4	10.0	5.5	148.3	2.2	150.5
Stand	39	308	60	368	7.1	10.5	7.8	85.0	36.4	121.4
Cut 4		56	—	56	6.4	—	6.4	12.4	—	12.4
Left		252	60	312	7.3	10.5	8.0	72.6	36.4	109.0
Control		820	36	856	5.7	10.4	6.0	145.2	21.1	166.3
Stand	45	220	92	312	7.7	11.2	9.0	70.7	62.8	133.5
Cut 5		92	8	100	7.3	10.5	7.7	27.1	4.8	31.9
Left		128	84	212	7.9	11.3	9.4	43.6	58.0	101.6
Control		708	56	764	6.0	10.8	6.5	139.0	36.7	175.7
Left	50	100	112	212	8.1	11.6	10.1	36.1	82.0	118.1
Control		588	72	660	6.3	11.3	6.7	127.0	50.0	177.0
Stand	56	80	132	212	8.5	12.3	11.0	30.6	108.4	139.0
Cut 6		52	8	60	8.2	11.0	8.7	19.2	5.3	24.5
Left		28	124	152	8.6	12.3	11.8	11.4	103.1	114.5
Control		456	100	556	6.6	11.8	7.8	108.0	76.5	184.5

[1]Pulp-sized trees were 3.6 inches to 9.5 inches, saw-log size trees 9.6 inches and larger, both affected by ingrowth.
[2]Average size is shown as d.b.h. of tree of average basal area.
[3]Twelve percent of these were unusable trees that died in natural thinning. Thereafter, the cutting precluded the mortality that continued to reduce the control stands after 30 years.

FIG. 5A.—Unthinned stand in 1916, trees crowded, death rate high, but losses confined to nonmerchantable stems.

FIG. 5B.—Same stand in 1936, after a mortality of 12 cords—an average loss of 0.6 cord per acre per year since 1916.

and the subsequent effects of the six cuttings on growth in that average size are shown in Figure 4B. Both effects contributed to the superior rate at which average size of trees increased on the thinned plot. Diameter is the first tree dimension to respond to additional growing space. Interior views of the stands in 1916 and 1936 are shown in Figures 5 and 6.

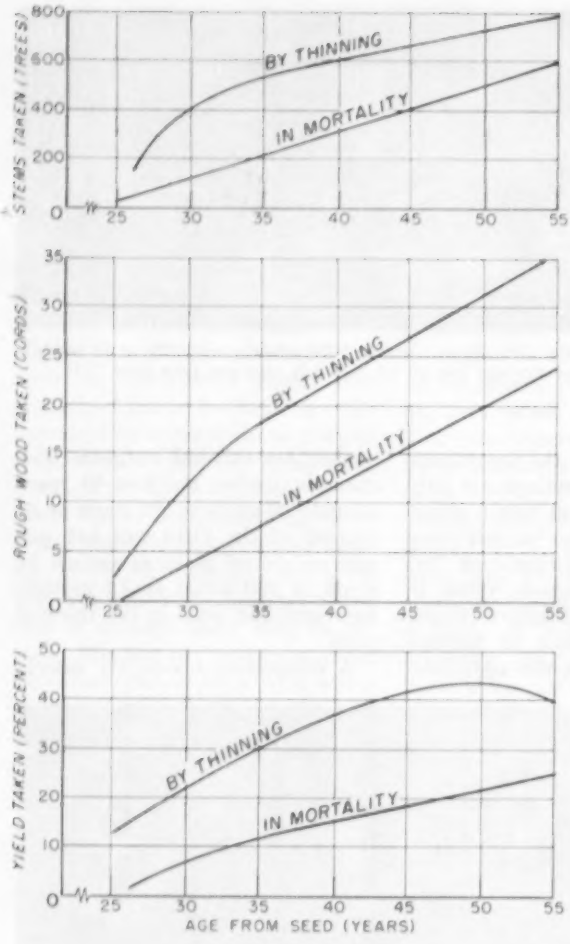
The average distance between trees 3.6 inches or larger in d.b.h., in terms of equivalent square spacing, was 7 or 8 feet at 20 years when thinning started. Twenty years later it was still about 7 feet unthinned but nearly 12 feet thinned. Now at 56 years it is nearly 9 feet unthinned and 17 feet thinned. In respect to average diameter and familiar rules of thumb, the unthinned spacing now is $1.1D$ or $D + 1.0$ and the thinned spacing $1.4\,D$ or $D + 5.1$ feet. The spacing is 12 percent of dominant height on the unthinned plot and 24 percent of dominant height on the thinned plot.

A comparison of the trends in natural and artificial thinning in relation to age of white pine may be of interest. A common loss of saplings in the first 20 years was 62 one-inch stems, 360 two-inch, and 294 three-inch ones, or a total of 760 nonmerchantable pines per acre. After that the merchantable trees taken by mortality in the absence of thinning are compared directly with those removed in thinning in Figure 7. Each pair of curves tells the story in different terms, trees per acre at A, cords per acre at B, and the percentage of yield at C. Thinnings not only salvage material that would otherwise be lost, but also harvest other trees inferior as growing stock. The cumulative intermediate yields in trees 3.6 inches and larger (upper curve) are composed of salvage (lower curve) plus the additional "take" for cultural purposes. For example, during the first 50 years roughly 20 cords in 505 stems or 22 percent of the yield was lost per acre on control plots, as against 31 cords in 730 stems or 43 percent harvested per acre on the thinned plots.

A compelling reason for reserv-

FIG. 6A.—After the first thinning in 1916.

FIG. 6B.—Before the fourth thinning in 1936. The volume of wood harvested in trees removed in the four thinnings was about 25 cords (4 in 1916, 12 in 1922, 5 in 1928, and 4 in 1936) or about 1¼ cords per acre annually since 1916. Nearly half of this was in trees that otherwise would have died and decayed in the same period.



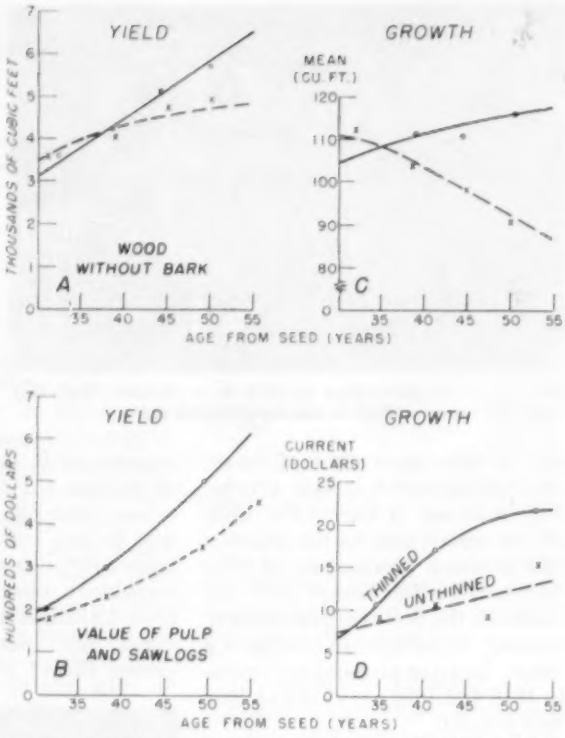


FIG. 8.—Production per acre of products at different ages is shown in volume at *A* and in value at *B*. Mean annual volume increment per acre is shown at *C*, and the current annual value increment at *D*. Data for each diagram include the cut but not the mortality.

FIG. 7.—Comparison of the trends in cumulative amounts of white pine removed by artificial and natural thinning during 30 years, *A*, trees per acre, *B*, pulpwood per acre, and *C*, the portion of total yield taken.

ing the better trees in thinning is to get saw timber sooner. The first saw-log trees cut were four per acre at 32 years. Twice as many were taken at 45 years and again at 56 years. This left, at 56 years, 124 saw-log trees per acre thinned and 100 per acre unthinned.

Growth and Yield

Merchantable volumes only are included in the following figures. From pulp-size trees and the tops only of saw-log trees the cumulative cubic-foot yield from thinnings plus the remaining stock is already 23 percent above the corresponding net yield without thinning. Similarly, the cubic volume of wood in saw logs only is 58 percent above the unthinned check. In combination, the total cubic volume from thinning is 35 percent above the control (last three lines of Table 2).

The trends in growth and yield are traced in Figure 8. The superiority of the thinned stand in volume growth was first evident at the age of 36 or 37 (note crossing of curves at *A* and *C*). Owing to the prior development of some saw logs, superiority in value production first appeared somewhat earlier, at about 30 years (curves *B* and *D*). Similarly, a few trees big enough for saw logs on the unthinned control plots are responsible for a steady rise in value growth (*D*) although the trend in mean annual volume growth (*C*) is down because of mortality among 4- and 6-inch trees.

The net 4,882 cubic feet per acre produced in 56 years (Table 2) without thinning is equivalent to 69.8 cords[2] or a mean annual increment of 1.2 cords. The 6,578 cubic feet per acre produced in the same period with thinning is about 89 cords or a mean annual increment of 1.6 cords. Thus the mean annual gain from thinning thus far, including both pulp and saw logs but expressed wholly in cords, is 0.4 cords or one-third of the net natural yield. Thinning increased the net yield of pole-sized trees alone only 28 percent, but meanwhile the "outgrowth" from this size class meant ingrowth in saw-log sizes. Obviously the full advantage from thinning cannot be shown without separate consideration of the board-foot volumes and values.

[2]Converting factors used are 70 cubic feet of peeled wood per rough cord unthinned and 74 cubic feet per cord on the thinned plot. These factors vary with the average size of the trees.

The saw-log yield from the thinned plot includes 1,796 board feet per acre taken in three light cuts. The total production with thinning was 50 percent greater in board feet than was the net production without thinning (last three lines of Table 3). Trees with saw logs have a higher value per unit of volume. The under-saw-log-size white pines are worth 4 to 5 cents per merchantable cubic foot, whereas the value per cubic foot in saw-log size trees ranged from 9 to 12 cents. With all stems in the 10-inch class or larger classified as saw-log trees and all other as pulp trees, the average values rose from 10 to 12 cents per tree at 20 years to an average of 80 cents each on the unthinned plots at 56 years. By contrast, on the thinned plots the trees cut at the last thinning were worth only 84 cents per tree, but those reserved at that time were worth $3.05 each. There are of course many more trees per acre on the unthinned plots, but even so their value per acre is well below that of the high quality material produced in the thinned plot. In 56 years an advantage of nearly 50 percent or about $200 per acre in stumpage value was gained by thinning.[3]

Discussion

Thinnings elsewhere confirm these results in part only, perhaps because of a later start. It is difficult to match sites well enough for valid inter-regional comparisons.

Mean annual growth of white pine at Biltmore on a site of index 67 was a little more than 1.5 cords at age 36. The mean annual growth of loblolly pine in Louisiana on a site of index 85 was 1.3 cords at age 36 (*5*, Tables 5 and 6, page 23). That is too early for much thinning effect. Another stand of loblolly pine in Louisiana (*15*) has had treatment similar to that at Biltmore.[4] It produced a periodic net annual growth of 2.16 cords thinned or 2.35 cords unthinned from 18 to 33 years of age. The author concludes that in producing only pulpwood from loblolly pine on fair or better sites, thinning is not warranted in the first 33 years because it neither shortens the rotation nor greatly increases the size of pulpwood sticks. On this plot, as at Biltmore, the advantage from early thinning was first evident at age 36. Where the loblolly pine thinning had been deferred 5 years, the yields did not surpass the check yields until about age 42.

Suitable levels of stocking for growing timber have yet to be determined. The "normal" or maximum amount of basal area per acre in relation to tree size, as shown by Stahelin (*16*) for loblolly pine, has not been ascertained for white pine. It can probably stand a somewhat higher "normal" level of growing stock than loblolly because it is more tolerant of shade. After treatment in 1953 the Biltmore white pine stands showed the following percentage of Stahelin's normal basal area for loblolly pine of the same average diameter: thinned 69 percent, and unthinned 122 percent. Both so far continue to rise slowly.

More pertinent comparisons, perhaps, may be made with the culture of white pine in the northeastern states. Over a period of 73 years the yield from 50 acres of white pine on a Vermont farm[5] closely approximated that at Biltmore. There the average annual yield was 107 board feet per acre from thinning and salvage plus 218 from final harvest. The total of 325 is comparable to the 335 board feet of annual yield in 56 years at Bilt-

[3] Pine logs from the Biltmore Estate, even where they are few as indicated in Table 3, are segregated in pulpwood sales and sawed into lumber. It pays because saw logs are worth about four times as much per cubic foot. When they are cut in inaccessible locations such integration of utilization may not be feasible. If all had been used merely as pulpwood in this experiment, the advantage from thinning would be $30 less, that is $170 per acre.

[4] Urania plot, U5, lightly thinned 5 times from below at 5-year intervals to residual basal areas averaging 99 square feet per acre. The check plot was near equilibrium at 152 square feet of basal area.

[5] Reported by the "Woodlands Editor" of American Forests in August 1947.

TABLE 2.—EFFECT OF SIX THINNINGS ON MERCHANTABLE CUBIC VOLUME PER ACRE OF WHITE PINES INCLUDING SAW LOGS

	Year and thinning	Saw-log portion	Tops of saw-log trees	Small trees	Total
	No.	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*
Volume	1916	.....	.....	1,790	1,790
Cut	1	.....	.....	247[1]	247
Left		.....	.....	1,543	1,543
Control		.....	.....	2,085	2,085
Volume	1922	.....	.....	2,309	2,309
Cut	2	.....	.....	694	694
Left		.....	.....	1,615	1,615
Control		.....	.....	2,880	2,880
Volume	1928	184	80	2,359	2,623
Cut	3	37	16	312	365
Left		147	64	2,047	2,258
Control		37	16	3,581	3,634
Volume	1935	662	272	2,108	3,042
Cut	4	.....	.....	280	280
Left		662	272	1,828	2,762
Control		377	156	3,496	4,029
Volume	1941	993	472	1,870	3,335
Cut	5	87	36	693	816
Left		906	436	1,177	2,519
Control		714	276	3,396	4,386
Test plot	1946	1,744	616	1,001	3,361
Control		1,016	376	3,146	4,358
Volume	1952	2,496	812	868	4,176
Cut	6	200	40	624	864
Left		2,296	772	244	3,312
Control		1,654	572	2,656	4,882
	Total yield of wood without bark in 56 years				
Thinned		2,620	864	3,094	6,578
Control		1,654	572	2,656	4,882
Difference		966	292	438	1,696

[1] Note: 9.7 percent of this was natural thinning. Thereafter, the cutting has precluded the mortality that continued to reduce control volumes in small trees (4-inch class and larger) after 1928.

more. Other northeastern stands, however, despite an apparent handicap in latitude, have surpassed the one at Biltmore.

On comparable sites and at similar ages in New Hampshire, white pine is reported to have produced some 10 M board feet more per acre of second growth (*8*) or 20 M more in plantations (*1*). The rate of diameter increment, 3.3 inches in ten years, approaches the 3.5 inches reported by Barrett (*3*) for northern Georgia. For a stand in Connecticut the mean annual growth is reported by Hawley and Lutz (*12*) to be 595 in a plantation thinned lightly when about 25 years old and possibly again a few years later.[6]

The old orchard plantation at Biltmore does not represent the growth potentiality of native Appalachian white pine on good soil. The seedlings for this plantation were raised in Germany from seed of uncertain American origin; they were handicapped by being planted on a worn out field; the roots of some trees are infected with a butt rot fungus; and they were overcrowded for the first 20 years. Without these handicaps, production would have been greater.

[6]This report is for the Greenfield Hill stand, one year older and with an estimated site index only 2 feet higher than that of the thinned plot at Biltmore. No record was kept of the volume removed.

Summary

An eroded site of index 67, closely planted to white pine of uncertain seed source in 1899, has been thinned from below six times since 1916, each time to a basal area of about 100 square feet. Trees cut were usually those with crowns less than 35 percent of total height. By 1953 there were 124 trees per acre big enough for saw logs in the thinned stand and 100 per acre unthinned. The trees average 4 inches larger in d.b.h. in the thinned stand. Spacing is now 12 percent of height on the unthinned plot, and 24 percent of height on the thinned plot. In 50 years 20 cords in 505 trees, or 22 percent of the yield, was lost in mortality per acre unthinned. On the thinned area mortality was arrested by harvesting 31 cords in 730 trees, or 43 percent of the yield. Mean annual increment is 1.6 cords with thinning and 1.2 cords without. Hence production at 56 years in merchantable cubic feet, including both pulp and saw logs, is 35 percent greater with thinning than without. Because trees with saw logs have a higher unit value, the full advantage from thinning is deferred until they have grown. So far, total production with thinning is 50 percent greater in board feet. The average stumpage value of each surviving tree on the unthinned plot is now 80 cents; the average reserved tree on the thinned plot is worth $3.05. On a per-acre basis the total stumpage value gained in 56 years by thinning is $198.40.

TABLE 3.—VOLUME AND VALUE OF WHITE PINE GROWING STOCK PER ACRE IN RELATION TO SIX THINNINGS[1]

Thinning No.	Date	Age from seed	Treatment	Pole-size trees & tops of others		Saw-log portions		Combined stumpage values	
				Volume	Value	Volume	Value	Total	Per tree
	Winter	Years		*Cords*	*Dollars*	*Bd. ft.*	*Dollars*	*Dollars*	*Dollars*
1	'16-'17	20	Cut	4.3[2]	12.90	.....	.....	12.90	.09
			Left	24.5	73.50	.....	.....	73.50	.10
			Control	33.1	99.30	.....	.....	99.30	.12
2	'22-'23	26	Cut	12.0	36.00	.....	.....	36.00	.10
			Left	24.5	73.50	.....	.....	73.50	.15
			Control	45.7	137.10	.....	.....	137.10	.15
3	'28-'29	32	Cut	5.2	15.60	296	7.40	23.00	.20
			Left	31.1	93.30	1,184	29.60	122.90	.34
			Control	57.0	171.00	296	7.40	178.40	.19
4	'35-'36	39	Cut	4.2	12.60	.....	.....	12.60	.22
			Left	30.0	90.00	5,024	125.60	215.60	.69
			Control	55.4	166.20	3,028	75.70	241.90	.28
5	'41-'42	45	Cut	10.4	31.20	656	16.40	47.60	.48
			Left	22.7	68.10	8,672	216.80	284.90	1.34
			Control	55.6	166.80	5,584	139.60	306.40	.40
6	'46-'47	50	Cut	.....	.....	.....	.....	.....	.....
			Left	22.5	67.50	12,628	315.70	383.20	1.81
			Control	51.8	155.40	7,792	194.80	350.20	.53
6	'52-'53	56	Cut	9.7	29.10	844	21.10	50.20	.84
			Left	13.3	39.90	16,940	423.50	463.40	3.05
			Control	46.1	138.30	12,360	309.00	447.30	.80
Total yield			Thinned	59.1	177.30	18,736	468.40	645.70	.....
			Control	46.1	138.30	12,360	309.00	447.30	.....
			Difference	13.0	39.00	6,376	159.40	198.40	.....

[1]The number of cubic feet of wood only per standard cord of bark plus wood varied from 58 for 4-inch trees to 74 for 12-inch trees. Regardless of the year, all the merchantable values are estimated at stumpage rates of $3 per rough cord and $25 per M bd. ft. (International ¼-inch rule).

[2]Of this, 9.7 percent was for natural thinning. Thereafter the cutting precluded mortality that, on the control plots, continued after 1928 to reduce the volume in 4- and 6-inch trees.

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Wildfire Damage Reduced on Prescribe-Burned Areas in New Jersey

E. B. Moore, G. E. Smith, and S. Little[1]

Prescribed burning is now a standard forest-management practice in the Pine Region of southern New Jersey. Reports on prescribed burning have emphasized its value as a silvicultural tool for favoring pine over oak.

Yet its value in reducing damage from wildfires—and in making wildfires easier to control—is equally important. Within the last few years there have been some striking examples of this.

THE PRACTICE of prescribed burning has been carried out in the South Jersey state forests for many years. It was originally initiated as a fire-protection measure on "safety strips" 25 to 200 feet wide bordering the roads, and was later expanded to entire tracts of forest following the disastrous wildfires of 1930. The silvicultural value of this practice in favoring the regeneration of pine became apparent later (*1, 2, 3, 4*).

The upland sites of the South Jersey Pine Region on which prescribed burning is used are occupied by a mixture of various oaks with pitch and shortleaf pine. The topography is flat or gently rolling, and the soils are sandy, falling mostly in the Lakewood, Evesboro, and Sassafras series. Earthworms and other soil fauna characteristic of mull humus are seldom found, and because of their absence and the low bacterial population, fungi are the chief agent in the disintegration of forest litter. Consequently, the litter accumulates on the surface as mor or duff, which—along with the shrubby understory—provides the basis for the exceptionally high hazard in this region.

Large unbroken tracts of woodland are characteristic of this region, but they are usually subdivided into many ownerships mixed with tax-delinquent land. This pattern made the practice of forestry by a single owner extremely hazardous, because of the chance of a highly damaging wildfire spreading from adjoining lands.

Consequently, for many years most private owners had not been interested in undertaking planting or any other silvicultural measures on their properties, and the practice of forest management in this part of the state had been limited mostly to the prevention and suppression of wildfires.

However, by 1947 the results of research and experience on the state forests finally provided a basis for extending assistance in pre-

FIG. 1.—This area had not been prescribe-burned before the wildlife of May 1951 swept through it. Sixty-four percent of the trees in such areas were killed or severely damaged. *Photo N. J. Dept. of Conservation and Economic Development*

[1]Respectively: chief of Forestry Cooperation Section, N. J. Dept. of Conservation & Economic Development; formerly forester, Soil Conservation Service, Woodbury, New Jersey; and forester, Northeastern Forest Experiment Station, U. S. Forest Service, Upper Darby, Pa.

FIG. 2.—This area had been prescribe-burned before it was burned over by the wildfire of May 1951. Compare this with Figure 1.
Photo: N. J. Dept. of Conservation and Economic Development

scribed burning to private owners. Under this program detailed plans are prepared, and the work is carried out under the supervision of state foresters (*2*). The response of private owners to this program has been so great that a start in constructive forest management has now been made on many properties. In the winter of 1952-53 sixty-one of these owners paid for this treatment on 14,000 acres of woodland.

Prescribed burning will not "fireproof" the woods, nor will it of itself stop most wildfires. However, used periodically, it so reduces the accumulated fuels that wildfires do not attain the intensity they do in untreated areas. This not only reduces the damage; it also increases the effectiveness of fire-control efforts. Both effects have been observed in certain recent wildfires, four in the Lebanon State Forest alone in the last 8 years.

Less Damage from Wildfires

A detailed study after one wildfire showed how damage to tree growth was reduced on areas that had been prescribe-burned. Opportunity for measuring the effect of prescribed burning occurred after a wildfire in May 1951. This fire started on land adjoining the 3,000-acre holding of E. I. du Pont de Nemours Company near Manumuskin in Cumberland County, and it burned over 1,200 acres of the du Pont land.

The du Pont Company had started a prescribe-burning program on this holding under the guidance of state foresters in the winter of 1948-49, and had continued it during the following two winters. Although some of the tracts treated the first winter could have been reburned in one of the following winters, this had not been done. Thus, of the 1,200 acres burned by wildfire in that property, 700 acres had been prescribe-burned once during the previous 3 years, and 500 acres had had no treatment.

A survey was made of this 1,200-acre burn in July 1951 to determine the effect of prescribed burning. Lines were run 40 chains apart, and 0.25-acre circular plots were taken at 10-chain intervals along each line. All trees 1.6 inches d.b.h. and larger were measured and tallied by species groups (pines and oaks), 1-inch diameter classes, and the following condition classes:

1. *Killed.*—Trees killed back to the ground, with or without sprouting from root collar.
2. *Severely damaged.*—More than half of the crown killed, with or without sprouting from root collar.
3. *Lightly damaged.*—Less than half of the green crown killed, and no sprouting from root collar.
4. *No damage.*

This survey definitely showed the value of prescribed burning in reducing wildfire damage. Where no prescribed burning had been done 64 percent of all the trees were either killed or severely damaged (Fig. 1), compared to an average of 17 percent in all areas treated once during the last 3-year period. In the areas treated the winter before this wildfire, none of the trees were killed or severely damaged.

The difference was obviously due to the smaller amount of fuel, and the consequent lower intensity of wildfire in the prescribe-burned areas. In the prescribe-burned areas the wildfire usually had the effect of a second prescribed burn, killing back chiefly small hardwoods in the understory (Figs. 2 and 3).

In some portions of the areas previously treated, particularly in one tract treated in the winter of 1948-49, damage was severe; but this area had been prescribe-burned when weather conditions prevented a satisfactory reduction of the fuels. In contrast, damage in the untreated areas was severe and widespread (Fig. 1).

As would be expected from previous studies (*1*), pines were damaged less than oaks in both treated and untreated areas. In treated areas the wildfire killed or severely damaged 8 percent of the pines, in untreated areas 58 percent. Comparable values for the oaks were 18 and 67 percent respectively.

Fire Control Made Easier

The value of prescribed burning in making fire-control work more effective has been observed in other cases of wildfires that spread onto lands that had been prescribe-burned.

Two wildfires that started in late April or early May and were not held along hard-surface roads were stopped after they encountered prescribe-burned areas. One has already been described (*2*). The other, a 1951 wildfire in the Bass River State Forest, was stopped on a one-lane sand road backed up by a prescribe-burned tract. In both of these cases damage within the prescribe-burned areas was negligible, and fire-control efforts were much easier and more effective than in untreated areas.

Under some circumstances, prescribed burning may have less influence. These include (1) times when wildfires encounter areas on which fuels have not been reduced recently enough or sufficiently, and (2) areas in the direct path of scorching heat from a very hot head-fire pushed by a strong steady wind.

When such a head-fire develops in South Jersey, it is nearly always in the pine-lowland sites. For example, a wildfire in April 1953, after sweeping through more than 0.6 mile of untreated pine-lowland sites, crossed a 2-lane sand road and burned the crowns of 40-foot pines in an open upland stand for about 400 feet—even though this stand had been prescribe-burned the previous winter and there was little fuel on the ground to support such a fire. However, outside the direct path of searing heat, prescribed burning proved markedly effective.

On one side of the main head-fire, a brushed-out property line in that same tract formed the boundary for 800 feet between killing damage on untreated land and little or no damage on the adjoining land that had been prescribe-burned. And no suppression efforts were attempted there. On the other side of the main head-fire, spot fires starting on prescribe-burned land were easily suppressed without causing any damage.

FIG. 3.—This area had also been prescribe-burned before the wildfire burned through it. Note that the killing damage was restricted to the hardwood understory; the pine overwood is uninjured. *Photo: N. J. Dept. of Conservation and Economic Development*

In April 1949 two wildfires started in areas prescribe-burned during the winter of 1947-48. Both were easily suppressed by direct attack even though one of the tracts had had only one prescribed burn. Damage in both tracts was negligible, although the two wildfires covered a total of about 7 acres.

Conclusions

Study of the du Pont burn and observation of other wildfires in the South Jersey Pine Region show that prescribed-burning treatments, made recently and adequately, not only reduce damage to tree growth markedly when wildfires spread onto treated areas, but also make fire-control efforts easier and more effective.

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Effects of the Forest Floor on Disposition of Rainfall in Pine Stands

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UNDISTURBED pine stands have a forest floor of accumulated organic debris through which rainfall must pass to reach the soil. In this process some rainfall is retained and later returned to the atmosphere by evaporation. Functioning as a ground cover, the forest floor can also have important effects upon surface runoff, percolation, and evaporation from the soil.

Much information is available showing the effects of the forest floor in increasing infiltration and reducing surface runoff rates (*1, 2, 3, 6*). Some information is also available showing that the forest floor reduces evaporation from the soil, thereby increasing the amount of water available to plant growth and percolation (*2, 4, 6*). Information is lacking, however, on evaporation from the forest floor itself.

This paper presents results of a series of studies designed to measure (1) evaporation from forest floors of pine stands in California; and (2) the influence of these floors on surface runoff, percolation, and evaporation from the soil.

[1]Maintained by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California.

The Study Areas

Two studies were conducted in a ponderosa pine forest on the west side of the Sierra Nevada, near Bass Lake, California, at an elevation of 3,350 feet. A third was carried on at North Fork, 6 miles southeast of the Bass Lake area, at an elevation of 2,750 feet; and a fourth at Berkeley, California at an elevation of 300 feet.

Climates of the study areas are characterized by wet winters, dry summers, and moderate temperatures. At Bass Lake annual rainfall averages 42 inches of which 30 to 40 percent normally occurs as snow. Winter temperatures average above 32° F., but frequently drop below freezing for short periods. Summer temperatures seldom exceed 100° F. The climate at North Fork, although warmer and slightly drier, is similar to that at Bass Lake. Annual rainfall averages 33 inches, of which less than 20 percent occurs as snow. At Berkeley winter temperatures are higher and summer temperatures lower than at the Bass Lake and North Fork areas. Average annual rainfall is about 25 inches, snowfall rare; and cool, foggy summers are the rule.

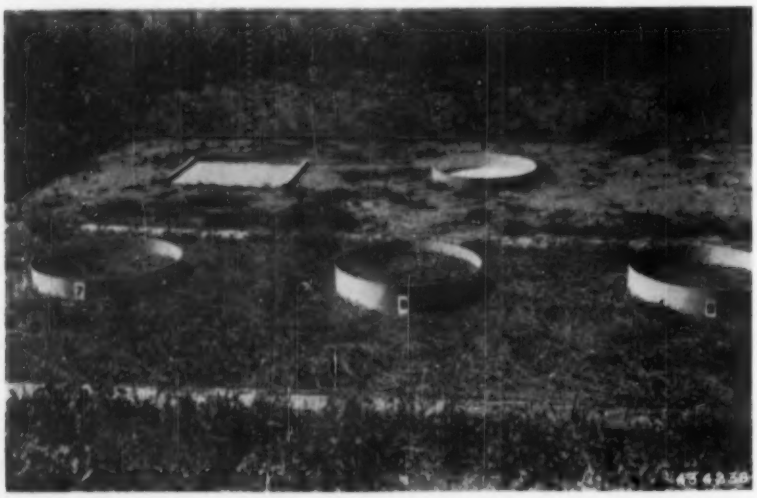

FIG. 1.—Bass Lake litter pans. Rainfall draining from the pans was caught in collector tanks placed in a pit just out of the foreground of this picture. Empty pan in background was used to measure precipitation. Canvas cover and graduated stake were used in sampling snowfall. F-434238.

Methods of Study

Evaporation from forest floors from stands of 20-, 70-, and 140-year-old ponderosa pine (*Pinus ponderosa*) was studied at Bass Lake in three circular litter pans (Fig. 1). The forest floors were collected by layers which were placed in the pans in their natural order of occurrence, each layer being pressed to the same average thickness and compactness as before disturbance (Table 1).

The litter pans, 5 inches deep and 500 square inches in area, were installed at ground level on a small flat in the center of a 300-foot opening in the pine forest. Two similar pans installed at the same location were used to measure precipitation. The pans were placed in the open to insure uniform rainfall catch. Amounts of precipitation retained by the forest floors and later lost by evaporation were determined for each storm as the difference between the total precipitation and the measured percolation from each pan.

Evaporation from undisturbed forest floor in the 70-year-old stand was also studied on a sampling plot situated on a north-facing, 40-percent slope about 400 feet west of the litter pan installation (Fig. 2). Precipitation was measured with a 12-inch intensity rain gage and an 8-inch standard rain gage in a small opening adjacent to the sampling area. Evaporation from the forest floor during periods when its moisture content was below field capacity was calculated from moisture determinations made after storm periods and at 7- to 15-day intervals throughout the rest of the year. The procedure used in computing this loss was the same as

that described by Rowe and Colman (5) in determining evaporative losses from soil. Evaporation when the moisture content of the forest floor was above field capacity was estimated from litter pan measurements. These estimates were based upon relations established between evaporation rates from the litter pan and undisturbed forest floor during periods when comparable records were available.

The influence of the forest floor on evaporation from the soil was studied at North Fork in two rectangular soil tanks or lysimeters (Fig. 3). These lysimeters were installed level with the ground in an open space on a westerly facing 27-percent slope. Each tank was 1,000 square inches in horizontal area (20 by 50 inches) and filled with 21 inches of sandy clay loam soil of the Holland series (4). The soil in one was maintained with a 2.5-inch covering of forest floor from a 70-year-old ponderosa pine stand near Bass Lake (Table 1). The other was kept bare. The same method was followed in collecting and handling the forest floor as in the Bass Lake litter pan study. Rainfall, surface runoff, and percolation were measured. Evaporation was computed annually as the difference between rainfall and the sum of runoff and percolation.

At Berkeley five rectangular lysimeters were used to study the influence of different depths of forest floor upon evaporation from the soil (Fig. 4). The lysimeters were installed in the open about 6 feet above ground at a 26-percent gradient. Each was 20 square feet in horizontal area (2.8 by 7.1 feet), and filled with 36 inches of clay soil of the Altamount series. On one tank the soil surface was maintained bare; on the other four it was covered with forest floors collected from 5-, 10-, 15-, and 25-year-old Monterey pine (*Pinus radiata*) plantations in the nearby hills (Table 1).

Methods of handling the forest floors and of determining rainfall, surface runoff, percolation, and evaporation were the same for the Berkeley as for the North Fork lysimeters. However, summer evaporation was computed from observations for only one season as the lysimeters were used for different studies during the summers of other years. Evaporation during the rainless summer period, therefore, was assumed to be the same each year. The validity of this assumption is supported by results of soil moisture studies at the North Fork and Bass Lake areas (5, pp. 38, 47, and 58).

FIG. 2.—Bass Lake sampling area, showing 70-year-old ponderosa pine stand and forest floor. (The graduated snow stakes are 6 feet in height.) F-388323.

TABLE 1.—FOREST FLOORS OF THE BASS LAKE LITTER PAN AND PLOT STUDIES, AND THE NORTH FORK AND BERKELEY LYSIMETER STUDIES

Type and age of stand in which found	Thickness of layers				Field[4] capacity
	L[1]	F[2]	H[3]	Total	
	Inches				
Bass Lake litter pan study					
Ponderosa pine, 20-25 years old	1.00	.....	.....	1.00	.09
Ponderosa pine, 70-80 years old	1.00	1.55	0.15	2.70	.32
Ponderosa pine, 140-160 years old	1.00	2.10	0.50	3.60	.44
Bass Lake plot study					
Ponderosa pine, 70-80 years old	1.00	1.55	0.15	2.70	.32
North Fork lysimeter study					
Ponderosa pine, 70-80 years old	1.00	1.25	0.25	2.50	.30
Berkeley lysimeter study					
Monterey pine, 5-10 years old	0.25	.....	.....	0.25	.02
Monterey pine, 10-15 years old	0.50	.....	.....	0.50	.04
Monterey pine, 15-20 years old	0.50	0.25	.....	0.75	.07
Monterey pine, 25-30 years old	0.50	0.50	0.25	1.25	.14

[1]L—Litter or uppermost layer of undecomposed needles and other organic debris.
[2]F—Duff or intermediate layer of partially decomposed litter, origin of material still recognizable.
[3]H—Humus or lowermost layer of decomposed organic matter next to mineral soil, origin not recognizable.
[4]Amount of moisture retained by forest floor after 60-72 hours drainage following saturation.

Evaporation from the Forest Floor

Evaporation from the three depths of forest floor in the litter pans at Bass Lake ranged from 3 percent to over 5 percent of the average annual precipitation during the study (Table 2). This evaporation is equivalent to an annual loss of about 78 acre-feet of water per square mile of forest floor 1 inch deep, 122 acre-feet per square mile of floor 2.7 inches deep, and 139 acre-feet per square mile of floor 3.6 inches deep. Evaporation from the three floors, however,

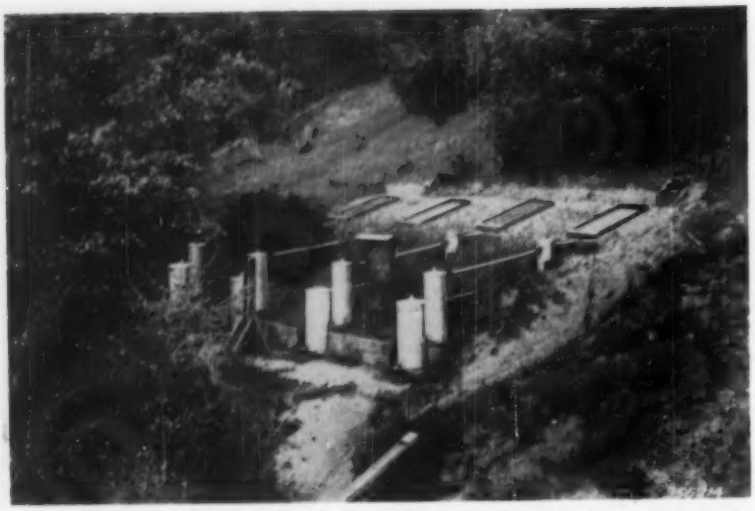

FIG. 3.—North Fork lysimeters. The bare soil and forest-floor-covered lysimeters used in this study are shown on the right. These conditions were duplicated in the next two lysimeters but were not continued throughout the period of study. Surface runoff and percolation from the lysimeters were caught in the collector tanks shown in the foreground. F-355214.

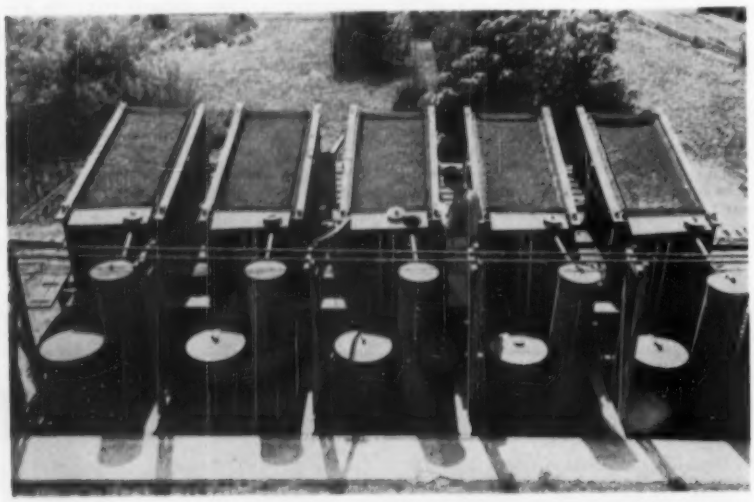

FIG. 4.—Berkeley lysimeters. From right to left are the bare soil and the ¼-, ½-, ¾-, and 1¼-inch deep forest-floor-covered soils. Rainfall was measured in trough gages along the sides of each lysimeter. Surface runoff and percolation were caught in the collector tanks in the foreground. CHG-2016.

TABLE 2.—ANNUAL EVAPORATION FROM FOREST FLOOR OF THREE PONDEROSA PINE STANDS—BASE LAKE LITTER PANS

Hydrologic year (Oct. 1 to Sept. 30)	Precipitation	Evaporation from forest floor					
		1 inch deep		2.7 inches deep		3.6 inches deep	
		Inches	*Pct. of precip.*	*Inches*	*Pct. of precip.*	*Inches*	*Pct. of precip.*
1941-42	52.54	1.59	3.0	2.72	5.2	2.91	5.5
1942-43	53.70	1.57	2.9	2.53	4.7	2.81	5.2
1943-44	38.30	1.21	3.2	1.92	5.0	2.28	6.0
1944-45	52.72	1.47	2.8	1.98	3.8	2.40	4.6
Annual average	49.32	1.46	3.0	2.29	4.6	2.60	5.3

was not proportionate to their depth. Annual evaporation per inch depth of floor averaged 1.5 inches from the 1-inch floor, but only 0.8 inch from the 2.7-inch floor, and only 0.7 inch from the 3.6-inch floor.

Variations in evaporation from year to year (Table 2) were due principally to differences in the duration of snow cover and the number and distribution of storms, particularly spring and summer storms. Variations caused by differences in the duration of snow cover were the most apparent. Percolation from snow melt in the litter pans (when the moisture content of the forest floors was at field capacity) was generally equal to or slightly in excess of the initial water content of the snow. This confirms results of earlier snow studies (*4*, p. 43) and indicates that net evaporation from the snow and the forest floor covered with snow was negligible. Effects of differences in the duration of snow cover on winter evaporation are indicated in Table 3.

As drying of the forest floor is much more rapid during spring and summer than during winter the number of spring and summer storms had a decided influence on total evaporation. In general, evaporation increased when the number of spring and summer storms (number of alternate wetting and drying periods) increased. Evaporation, however, was not influenced appreciably by the quantity of precipitation in excess of the amount required to wet the floors to field capacity. These relations are illustrated in Table 4.

The amount of precipitation retained by the forest floors during a storm was dependent upon their initial wetness (field capacity minus moisture content at the start of the storm). Retention of precipitation between times of equal moisture content, then, is a measure of evaporation from the floor during this period. The moisture contents of the forest floors in the litter pans were about the same at the start of each hydrologic year (October 1). Hence the total annual retention

(precipitation less percolation) is a measure of annual evaporation. Plotted with precipitation as in Figure 5, curves of cumulative retention show the relation of this water loss to storm occurrence.

At the start of the 1942-43 rainy season the forest floors were air-dry; moisture contents ranged from less than .01 inch in the floor 1 inch deep to about .04 inch in the floor 3.6 inches deep. Although small storms occurred on October 11 and November 3, the floors were not wet to field capacity until the storm of November 15. Differences in amounts of water retained by the floors during this wetting period were due principally to the greater amount required to wet the deep than the shallow floors to field capacity. In the period after the initial wetting (November 20-January 18), storms were widely spaced and evaporation was greatest from the deepest floor which contained the greatest amount of water available for evaporation.

During the remainder of the winter (January 24-March 30) when storms were frequent and the floors continuously wet, evaporation from the three floors was about equal. But as the frequency of storms decreased toward the end of the rainy season, evaporation again was greatest from the deepest floor which had the highest water storage capacity. Thus, although winter evaporation was about the same from the three floors the total annual loss was 0.96 of an inch more from the 2.7-inch floor, and 1.25 inches more from the 3.6-inch floor than from the 1-inch floor.

Annual evaporation from the forest floor 2.7 inches deep in the litter pan (within a forest opening) ranged from 16 to 24 percent higher than that from the similar undisturbed floor within the 70-year-old pine stand. This water loss from the floor in the pan averaged 2.29 inches (Table 2), whereas evaporation from the undisturbed floor averaged 1.90 inches (Table 5). Although quantities varied, differences in duration of snow cover and in the number and distribution of storms caused the same kind of variations in annual evaporation from the undisturbed floor as from that in the litter pan.

In 1942-43 the cumulative evaporation from the undisturbed forest floor was 2.1 inches (Fig. 6), or about .4 inch less than from the similar floor in the litter pan (Fig. 5, curve 2). During the fall wetting period (October 1 to November 15) and the spring-summer drying period (May 4 to September 30), the evaporation from the undisturbed floor was .73 inch and that from the pan .74 inch. The difference in the water loss from the two floors, then, was principally due to differences in evaporation during the rainy season.

In the spring-summer and fall periods, when storms were infrequent, evaporation from the forest floor was largely limited to the amount of precipitation retained in the floor and available for evaporation. During these periods the stor-

Table 3.—Effect of Difference in Duration of Snow Cover on Winter Evaporation

Dec. 1 to Mar. 31	Duration of snow cover	Evaporation from 1-inch floor	Evaporation from 2.7-inch floor	Evaporation from 3.6-inch floor
	Days	*Inches*	*Inches*	*Inches*
1942-43	26	.88	1.02	1.08
1941-42	63	.45	.76	.80
1944-45	84	.19	.21	.24
1943-44	91	.04	.08	.11

Table 4.—Relation of Evaporation to Frequency of Spring and Summer Storms

April 1 to Sept. 30	Number of storms	Rain (average per storm)	Evaporation from 1-inch floor	Evaporation from 2.7-inch floor	Evaporation from 3.6-inch floor
		Inches	*Inches*	*Inches*	*Inches*
1942-43	6	.55	.58	1.30	1.47
1941-42	8	1.36	.80	1.44	1.63
1944-45	9	.40	.97	1.50	1.75
1943-44	12	.46	1.05	1.67	1.84

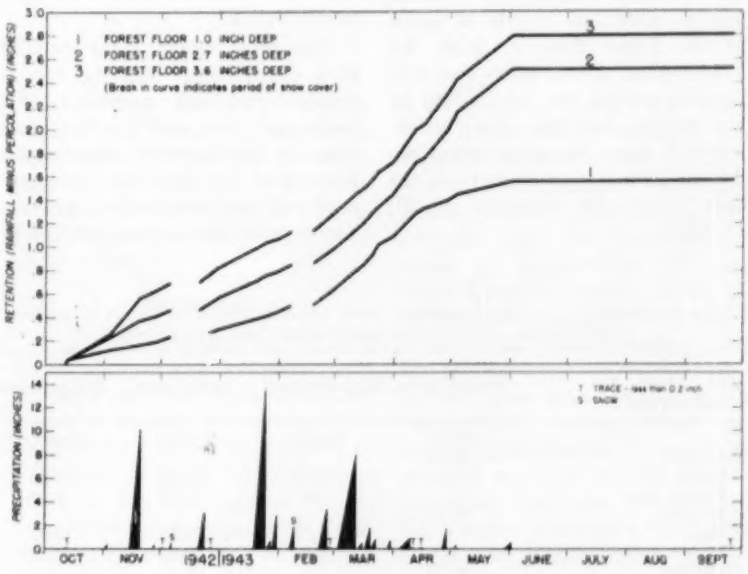

Fig. 5.—Cumulative retention of rainfall by three depths of forest floor, Bass Lake litter pan study, October 1, 1942 to September 30, 1943.

TABLE 5.—ANNUAL EVAPORATION FROM THE UNDISTURBED FOREST FLOOR 2.7 INCHES DEEP IN 70-YEAR-OLD PONDEROSA PINE, BASS LAKE PLOT

Hydrologic year (Oct. 1-Sept. 30)	Rainfall	Evaporation
	Inches	*Inches*
1941-42	50.6	2.2
1942-43	50.9	2.1
1943-44	38.5	1.6
1944-45	49.6	1.7
Yearly average	47.4	1.9

age curve of Figure 6 shows that evaporation was most rapid when the floor was wettest and decreased to insignificant amounts as it dried. After the last spring drying, losses during the rainless summer were negligible. During the rainy season (November 16 to May 3) there was a continuous supply of water in the forest floor available for evaporation. Hence water loss during this period was not limited by the supply but was directly dependent upon the evaporation potential, which was higher in the open than in the forest (*2*, pp. 51, 71, 152).

Influence of Forest Floor on Evaporation, Runoff, and Percolation

Average annual runoff from the soil covered by a forest floor in the North Fork lysimeters was 0.33 inch, about one-fortieth of that from the bare soil (Table 6). Evaporation, part of which was from the forest floor, was 7.9 inches or only about six-tenths of that from the bare soil. Percolation, on the other hand, was 28.6 inches or about three times that from the bare soil. The differences in surface runoff, percolation, and evaporation between the covered and bare soils were greater during the 1941-42 and 1944-45 seasons of heavy rainfall than during the 1943-44 season of more moderate precipitation.

The total water yield (runoff plus percolation) for the forest-floor-covered soil averaged 28.9 inches per year or 5.7 inches more than for the bare soil. Ninety-nine percent of this yield from the covered soil was percolation, as compared with 43 percent from the bare soil. Moreover, percolation started 20 to 30 days sooner and lasted from 50 to 80 days longer each year from the covered soil than from the bare soil.

Trends in water relations between the covered and bare soils in the Berkeley lysimeters (Table 7) were essentially the same as those of the soils in the North Fork lysimeters. Quantities, however, varied appreciably owing to differences in climate and experimental treatments employed. As previously explained, evaporation from the Berkeley lysimeters during the rainless summer period was assumed to be the same each year. Based on one year's observations, this loss ranged from 2.7 inches from the soil with a 1¼ inch depth of forest floor to 3.2 inches from the bare soil.

Annual surface runoff and evaporation were highest from the Berkeley lysimeter with bare soil and next highest from the lysimeter with the ¼-inch depth of forest floor. Surface runoff was about equal from the lysimeters with the ½-, ¾-, and 1¼-inch floor depths, but evaporation decreased slightly as the floors became deeper. Percolation, on the other hand, was least from bare soil, but increased with increase in floor depths in the same amounts that surface runoff and evaporation decreased. Under the conditions of this experiment, then, increases in the forest floor beyond the ½-inch depth appeared to gain nothing in the control of surface runoff, but did result in small decreases in evaporation and corresponding increases in percolation.

TABLE 6.—INFLUENCE OF A PONDEROSA PINE FOREST FLOOR ON SURFACE RUNOFF, PERCOLATION, AND EVAPORATION, NORTH FORK LYSIMETERS

Year[1] (Oct. 1-Sept. 30) and soil cover	Precipitation	Surface runoff	Percolation	Evaporation
	Inches	*Inches*	*Inches*	*Inches*
1941-1942	39.91			
Bare		14.40	11.28	14.23
Forest floor		0.65	31.65	7.61
1943-1944	27.98			
Bare		8.57	8.36	11.05
Forest floor		0.05	20.65	7.28
1944-1945	42.51			
Bare		16.93	10.03	15.55
Forest floor		0.29	33.38	8.84
Yearly average	36.80			
Bare		13.30	9.89	13.61
Forest floor		0.33	28.56	7.91

[1]Record for 1942-43 incomplete, hence omitted.

TABLE 7.—INFLUENCE OF FOUR DEPTHS OF MONTEREY PINE FOREST FLOOR ON SURFACE RUNOFF, PERCOLATION, AND EVAPORATION[1], BERKELEY LYSIMETERS

Depths of forest floor	Precipitation	Surface runoff	Percolation	Evaporation
	Inches	*Inches*	*Inches*	*Inches*
Bare soil	22.7	5.9	6.1	10.7
¼-inch	22.7	2.2	11.9	8.6
½-inch	22.7	0.5	14.7	7.5
¾-inch[2]	22.7	0.3	15.3	7.1
1¼-inch	22.7	0.5	15.4	6.8

[1]Average of 1935, 37, 38, and 39 rain seasons; records for 1936 incomplete, hence omitted.

[2]Periodic workings of ants in the soil of this lysimeter may have influenced slightly surface runoff and percolation amounts.

Discussion and Conclusions

The forest floor performs the dual function of (1) absorbing and holding precipitation for evaporation, and (2) increasing infiltration and reducing evaporation from the soil. Since the forest floor is subject to change, these functions need to be considered in the management of forested watersheds wherever floods and yields of usable water are matters of concern.

Average annual evaporation

from a pine floor 3.6 inches deep at Bass Lake was 2.6 inches (about 140 acre-feet per square mile), or almost twice that from a floor 1 inch deep. From deeper floors or in areas of less snowfall than Bass Lake, evaporation would exceed these amounts. In areas where precipitation occurs principally as snow, evoporation from all depths of floor would be small and limited mainly to the late spring and summer drying period. In such areas the greatest loss to water yield due to evaporation from the forest floor would be the water required to wet the floor to field capacity after summer drying. This loss would range from 4 to 5 acre-feet per square mile for a forest floor 1 inch deep to more than 21 acre-feet per square mile for a floor 3.6 inches deep.

Although annual evaporation from the forest floor can reach important amounts, results of the lysimeter studies indicate that this loss is more than compensated for by the saving in evaporation from the soil beneath the floor. Also, the forest floor, by increasing infiltration, greatly reduced surface runoff and increased percolation. Plot studies at Bass Lake, to determine the influence of the 70-year-old ponderosa pine on the disposition of precipitation (*5*), confirm the lysimeter results. Annual removal of the forest floor and scant herbaceous ground cover on these plots by burning resulted in greatly increased surface runoff and erosion and decreased percolation, with no reduction in the total evaporative losses (evapo-transpiration and interception loss).

In the present study, surface runoff was less for soils with a forest floor ½ inch deep than for soils with a shallower covering, but was about the same for all soils with forest floors ½ inch or more in depth. Although annual evaporation from the forest floor itself increased as the depth of the floor increased, the sum of evaporation from the floor and soil decreased. This decrease in evaporation, however, was very small for increases in the forest floor beyond the ½-inch depth. Hence, in pine forests such as those along the western slope of the Sierra Nevada, forest floors ½ inch or more in depth appear to maintain high infiltration capacities of the soil and to control total evaporation better than floor of lesser depths.

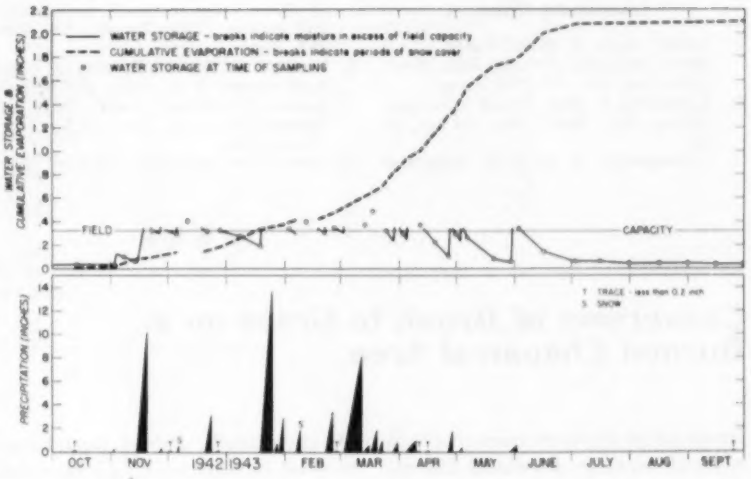
WATER STORAGE - breaks indicate moisture in excess of field capacity
CUMULATIVE EVAPORATION - breaks indicate periods of snow cover
WATER STORAGE AT TIME OF SAMPLING
WATER STORAGE & CUMULATIVE EVAPORATION (INCHES)
FIELD CAPACITY
PRECIPITATION (INCHES)
T TRACE - less than 0.2 inch
S SNOW
OCT NOV 1942 1943 FEB MAR APR MAY JUNE JULY AUG SEPT

FIG. 6.—Water storage in and cumulative evaporation from the undisturbed forest floor 2.7 inches deep, Bass Lake plot study, October 1, 1942 to September 30, 1943.

Summary

This paper presents results of a series of litter pan, lysimeter, and moisture sampling experiments designed to measure (1) evaporation from forest floors of pine stands in California, and (2) the influences of these floors on surface runoff, percolation, and evaporation from the soil. Three studies were carried on in the west-side ponderosa pine forest of the Sierra Nevada near Bass Lake and North Fork, California. A fourth study of forest floors from Monterey pine stands was conducted at Berkeley, California.

Annual evaporation as measured in litter pans placed in a forest opening averaged 1.5 inches from a ponderosa pine floor 1.0 inch deep, 2.3 inches from a floor 2.7 inches deep, and 2.6 inches from a floor 3.6 inches deep. The loss from the floor 2.7 inches deep was about 0.4 inch or 21 percent greater than from a similar undisturbed floor within the pine forest.

Evaporation from the forest floor varied with the depth of floor, duration of snow cover, and number and distribution of storms. During winter, when storms were frequent and the floors continuously wet, evaporation was about equal from all depths. When the floors were covered with snow, evaporation was negligible. During the remainder of the year when storms were more widely spaced, particularly during spring and summer, evaporation was more dependent upon the amount of water in storage and was greatest from the deepest floors with the highest water storage capacities.

In lysimeters surface runoff and evaporation were much greater and percolation correspondingly less from bare than from forest-floor-covered soils. Percolation started sooner and lasted longer each year from the covered than from the bare soils. These differences in surface runoff and percolation were much more pronounced during years of heavy than during years of moderate or light rainfall.

Under the conditions of this study forest floors ½ inch deep controlled surface runoff and total evaporation nearly as well as floors of greater depths and better than floors of lesser depths.

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Conversion of Brush to Grass on a Burned Chaparral Area

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INTEREST in the conversion of brush covered areas to grassland has received fresh impetus of late. The development of hormone sprays has supplied a new method of keeping out invading and sprouting chaparral species without recourse to too frequent burning. Research and field experience have demonstrated that grass is an excellent cover both for erosion control and for soil improvement (*1, 4*); and recent extensive work on developing hardy grasses for a variety of conditions has resulted in making available new strains of species which are able to provide cover even on sites which have coarse soil and steep slopes (*2, 3*).

Consequently it was thought of interest to report the experimental conversion to grass, subsequent to a fire, of a small area of Southern California chaparral land.

The area studied is in the foothills of the San Gabriel Mountains at an elevation of about 1,100 feet. The slopes vary in steepness from 40 to 80 percent. On the north slopes the cover consists of scrub oak (*Quercus dumosa*). Western mountain mahogany (*Cercocarpus betuloides*), chamise (*Adenostoma fasciculatum*), and a number of small herbaceous plants. On the south slopes chamise is the dominant species in association with laurel sumac (*Rhus laurina*) and mountain lilac (*Ceanothus crassifolius*).

In open spaces on both exposures there are patches of annual grasses such as rip-gut (*Bromus rigidus*) and red brome (*Bromus rubens*).

The soil profile was generally shallow derived from diorite. For the most part the soil is sandy loam, moderate to low in organic matter.

Temperatures show a large diurnal variation. In winter, which is the growing season, the average minimum and maximum may be 40°F and 65°F, with freezing temperatures occasionally. Yet there are hot spells in winter when temperatures on the south slopes may be 100°F or over. The north slopes are appreciably cooler. Soil moisture is also higher on north slopes. As a consequence, the north slopes support growth of good litter-producing species such as scrub oak, laurel sumac, and western mountain mahogany; on the south slopes on the other hand, with chamise as the dominant species the litter production is rather scant.

On November 3, 1949, a fire occurred which burned 150 acres of this land. The fire, of incendiary origin, started on a hot day with a temperature of 90°F, an extreme low relative humidity of 9, and a fuel moisture of 0.5 percent. The fire was intense, killing the tops of all plants and consuming litter and all but the larger stems of the scrub-oak and laurel sumac. A thick layer of white ash covered the ground.

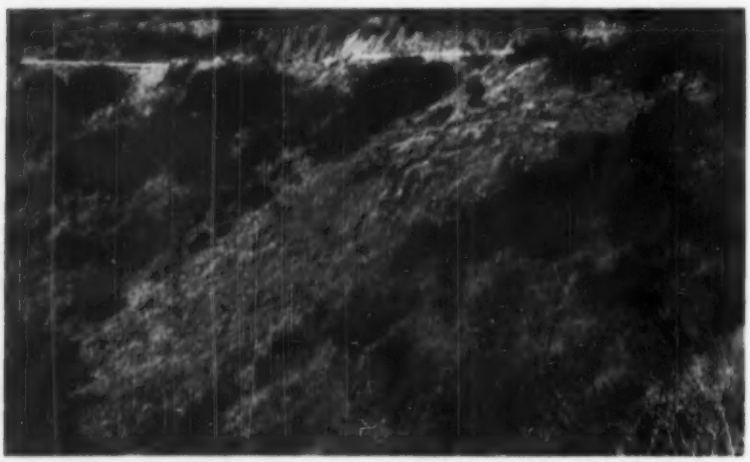

Photo U. S. Forest Service

FIG. 1.—Established grass on sprayed plot, south exposure.

Establishing Grass Cover

After controlling the fire the immediate problem was to establish the best possible cover to control

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erosion from winter rains. A cooperative reseeding program was set up by the Los Angeles County Forestry Department, the U. S. Forest Service, and John Muir College of Pasadena. Seeding of mustard (*Brassica nigra*) has been considered the quickest method of restoring cover on burns in this area, and is the one most commonly used. However, since much progress has been made in development of grasses for arid regions and poor soil and since grass is considered one of the best soil-builders, it was decided to seed the area with grass.

In January 1950, approximately 120 acres were hand seeded by the botany and forestry students of John Muir College. Italian ryegrass (*Lolium multiflorum*) was used at a rate of 8 lbs. per acre. About 30 acres were left unseeded as a control. In addition, square meter plots were seeded with mountain brome (*Bromus carinatus*), orchard grass (*Dactylus glomerata*), Wimmera ryegrass (*Lolium subulatum*) and red fescue (*Festuca rubra*) from seed developed by the U. S. Soil Conservation Service nursery, San Fernando, but not at that time available in large quantities.

The total rainfall in 1949-50 amounted to only 14.55 inches, or 58 percent of normal (Table 1). However, the spacing of the rains was favorable for germination. The rainfall in 1950-51 was also below normal; in 1951-52 it was above normal, with 41.3 inches. In 1952-53 it was again below normal.

The first year growth of the Italian ryegrass was rapid and a dense stand was formed, most dense on the north slopes. A large seed crop was produced. During the second and third year there was an increase in density.

On the small test plots, mountain brome and Wimmera ryegrass also produced dense stands. Orchard grass and red fescue made thin stands and disappeared the following year. Wimmera ryegrass stayed green longest.

By May of 1950, scrub oak, laurel sumac, chamise, western mountain mahogany and other brush had resprouted vigorously from the crowns. This would have resulted in the area being taken over by the original cover. From the stand point of fire control, grass would be preferable to brush since in this area a grass fire would be more easily controlled. From the erosion control standpoint, also, the grass was excellent. The latter was demonstrated during the heavy rains of 1951-52. There was no soil loss, but a well dissipated runoff of clear water; while on unseeded areas there was severe gullying. At this time the chaparral plants had sprouted and the tops afforded some measure of the control that might be expected of them; that is to say, that while a full comparison between the efficacy of grass versus chaparral could not be made, the indications were that the grass was better. At any rate, it was effective.

Table 1.—Rainfall on Katherine Burn, Flintridge Area, 1949-1953

Month	1949-1950	1950-1951	1951-1952	1952-1953
September	—	.76	—	.22
October	.18	.60	1.68	—
November	2.22	1.61	2.73	5.51
December	3.96	—	7.81	3.04
January	2.90	3.94	15.83	1.24
February	2.59	1.49	.92	.13
March	1.47	.41	9.45	1.43
April	.87	2.83	2.92	1.37
May	.19	.05	—	.03
June	.17	—	—	.10
July	—	—	—	—
August	—	—	—	—
	14.55	11.69	41.34	13.07

20-year average—24.8 inches
75-year normal—22.55 inches

Spray Plots

In May 1950 two plots, each 100 x 100 feet, were selected and sprayed with a mixture of 2,4-D and 2,4-5-T (Weedone Brush killer 32). One plot, with a south exposure, had a slope of 60 percent. The other, with north exposure, had an average slope of 47 percent. The composition of the cover on the north slope plot, determined by actual count, was 41 percent western mountain mahogany, 27 percent scrub oak, 9 percent currant and 8 percent chamise. The remaining 15 percent was of miscellaneous species such as poison oak, Santa Barbara honeysuckle, and red berry. Cover on the south slope plot was 62 percent chamise, 32 percent laurel sumac, and 6 percent goose berry.

Soil, Soil-depth, and Grass Cover on the Sprayed Plots.—Bed-rock on the north-facing slope was at 20 inches; on the south-facing slope at from 12 to 18 inches. Soil profile on the north slope consisted of a sandy loam surface overlying a somewhat lighter textured subsoil, which in turn graded into the disintegrating diorite bed-rock.

Soil profile on the south slope was similar to that on the north slope except on the upper portion, where there was some variation. It was here that bed-rock was at only 12 inches with a granular sandy loam overlaying subsoils, which varied from sticky loams to coarse sandy material. The soil on the north-facing slope had a pH concentration of 6+; on the south slope the pH ranged from 6 on the upper portion to 6.5 on the lower. This was taken colorimetrically.

Organic material was moderate to low on both plots, as determined by observation of a dozen samples.

In 1953 the amount of bare areas between the tufts of grass on the north slope plot was estimated at about 1 percent. On the lower portion of the south slope plot the bare area was about 5 percent, and on the upper portion of the plot about 30 percent. Based on observation, this is somewhat less than it was in 1951, so the grass had made some gain even where the soil depth was only 12 inches. Soil samples showed a network of roots, as yet undecomposed.

On the unsprayed areas competition of sprouting shrubs and invasion of deerweed (*Lotus scoparius*) was slowly forcing the retirement of the grass cover. In Figure 1 the borderline of the sprayed plot can be readily seen, where the low dark mounds of the resprouting shrubs were already beginning to close the cover.

Application of chemicals.—Weedone Brush Killer 32[2] containing an acid equivalent of ⅔ lbs. 2,4-5-T and 1⅔ lbs. 2,4-D per gallon was mixed with diesel oil in the proportion of 1 to 4. A 4-gallon Hudson pack pump with attached CO_2 pressure bottle mounted on a pack frame was used in the application. The power bottle maintains adequate pressure and eliminates the need for manual pumping. The mixture was sprayed with an 8 foot boom equipped with a trigger-type shutoff valve and fan-type nozzles with a discharge rate of 0.15 gpm. The spray was applied uniformly at a rate of 10 gallons per acre. This was done in May 1950, October 1951, and June 1953. At this elevation it is usually considered that chaparral plants are not dormant in May or June, but in October they were probably still in their summer dormancy, since no rain had fallen since the previous spring.

On the north slope the first application killed chamise, honeysuckle (*Lonicera subspicata*), poison oak (*Rhus diversiloba*), and red berry (*Rhamnus crocea ilicifolia*). A second application was required by western mountain mahogany. Still a third was required for scrub oak and currant (*Ribes malvaceum*).

On the south slope chamise was not killed until the second spraying. Laurel sumac required three applications.

There were a number of seedlings of chamise, western mountain mahogany, and mountain lilac which were not of sufficient height to be reached by the spray until the time of the second spraying (October 1951). These were killed by the one application. New seedlings continued to appear as late as the fall of 1952, but were killed in the third spraying in 1953 (Table 2). No more seedlings have appeared on either slope since the fall of 1952.

[2]Manufactured by the American Chemical Paint Co., Amber, Pa.

TABLE 2.—BRUSH SPRAYING ON KATHERINE BURN, FLINTRIDGE AREA

	Number of plants sprayed		
	May 1950	October 1951	June 1953
North slope, Plot 100 x 100 feet, sprayed with Weedone Brush Killer 32			
SPECIES			
Adenostoma fasciculatum	14	—	—
Cercocarpus betuloides	74	29	—
Lonicera subspicata	5	—	—
Quercus dumosa	49	35	7
Ribes malvaceum	17	3	3
Rhus diversiloba	10	—	—
Rhamnus crocea ilicifolia	9	—	—
	178	67	10
SEEDLINGS			
Adenostoma fasciculatum	Not counted	12	11
Cercocarpus betuloides	Not counted	10	11
Ceanothus crassifolius	Not counted	16	13
		38	35
South slope, plot 100 x 100 feet, sprayed with Weedone Brush Killer 32			
SPECIES			
Adenostoma fasciculatum	62	15	—
Ribes speciosum	6	—	—
Rhus laurina	32	27	6
	100	42	6
SEEDLINGS			
Adenostoma fasciculatum	Not counted	8	—
Ceanothus crassifolius	Not counted	76	11
Rhus laurina	Not counted	36	7
Quercus dumosa	Not counted	—	3
Ribes speciosum	Not counted	—	1
		120	22

Discussion

Italian ryegrass is an introduced species from Italy. The choice of a standardized strain of grass commercially produced and consequently available at all times in large quantities, was made in the interest of being able to reproduce results in similar sites. While the first qualification of grasses in these arid mountains is that they survive, and there are native or naturalized grasses maintaining themselves in small, scattered areas through the mountains, they are often so complex genetically that the bulk of the seed crop produces plants with greatly varying characteristics. Only a small proportion of their seed will germinate in one set of conditions, so a heavy cover is not likely to be produced. Many recently introduced species have in numerous trials produced a heavy cover or shown themselves able to increase their extent in problem areas where natives or older, accidental introductions have not done so. This is in line with botanical theories, which hold that since seed is so widely disseminated over a continent, the absence of a particular species in an area means that conditions in that area are not suited to it; hence it is useless to try to make it grow there. (A qualification may be made to this principle, i.e., the range of a species within a continent may be increased or decreased in accordance with long-time weather cycles or changes). An introduction from another continent, however, may well succeed, particularly if from an area whose geological-ecological features show a further advancement along the same lines as those of the areas to which it is to be brought. For example, the regions bordering the Mediterranean, some of which were once like our mountains and foothills but are now in a more advanced state of denudation and dessication.)

Mountain lilac, laurel sumac, and chamise appeared on the grass covered areas in virtually the same number as in the unseeded places. No inhibition by the Italian rye-

grass was evidenced, such as has been observed on areas covered by mustard or barley (5). No inhibition of any species was noticeable, since seedlings of all species occurred in roughly the same proportion on unseeded as on seeded areas.

In the first two winters, both germination and seed set were sufficient for the grass to maintain itself, even though rainfall was far below the 75-year normal. In the third year, with nearly double the normal rainfall, the grass vigorously encroached on the few spots which had been scantily covered before, and made a higher stand with more seeds to the stalk. But in 1952-53, early establishment was poorer to begin with, and the grass which did grow produced less seed. Since the rainfall of 1952-53 was about equal to that of 1950-51 (13.07 as against 11.69 inches) this falling off of productivity must be accounted for on other grounds. One possibility might be the timing of the rains. In 1950-51, most of the rain came in January, February, and April (8.67 inches). In 1952-53, it came mostly in November and December with only about 3 inches after January. The light rains of March and April (2.7 inches) had so little effect that no soil moisture could be detected by the day following the storm. The time of flowering of Italian ryegrass is March and April. Poorer seed production can fairly confidently be ascribed to drought at that time. It is not so easy to account for the less vigorous early establishment.

Temperatures in the two growing seasons were remarkably similar, even to the pattern of maxima and minima in conjunction with the rains. In 1950-51, three rains came close together in January, followed by suitable temperatures. In 1952-53, there were three rains close together in December, followed by the same temperature pattern. Italian ryegrass usually germinates in January, so the time of these rains may have been critical.

However, there seems room for doubt that a difference of a few weeks would be the sole cause, particularly as there was again a light rain early in January. It seems probable that additional factors are humidity, evapo-transpiration, and possible radiation. In 1952-53 the relative humidity during this period was lower by 10 percentage points than in the corresponding period in 1950-51. On many days it was only 8 percent, and temperatures were high. Soil moisture, as determined by observation, was not so well maintained. There is evidence that even dew, which is a product of a complex of air moisture, radiation, and temperature, may exert an appreciable effect on soil moisture. Definite measurements of these factors now in progress may yield considerable information.

Whatever the cause of the less vigorous growth in the bad year, there still appeared to be enough of a seed crop for the grass to regain its density if a good year followed. Only observation over a period of years will show whether the cover can maintain itself permanently or whether additional cultural treatment such as a fertilization program or preferably, conversion to one of the perennial grasses, should be worked out.

Summary

A thick cover of Italian ryegrass was established on an area in the foothills of the San Gabriel Mountains previously denuded by fire. This grass species forms a satisfactory cover from the standpoint of erosion control and the relative ease of controlling fire. Reestablishment of the original chaparral cover was prevented by three spray applications of a mixture of 2,4-D and 2,4-5-T. At the time of preparation of this report, the cover had been self-maintaining for 4 years, having increased in density in favorable years, and decreased somewhat in a winter of little rain and high temperatures. Small experimental plots of various grasses showed favorable results for mountain brome and Wimmera ryegrass, less favorable results from orchard grass and red fescue.

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Pruning to Different Heights in Young Douglas-Fir

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A STUDY was started in 1937 at the Wind River Experimental Forest located at Carson, Washington, to measure the effect of pruning the live crown of young Douglas-fir to different heights. The trees were remeasured for the second time in the summer of 1950, 13 years after the original treatment. The study showed that one-third of the live crown length can be removed without harmful effect.

Study Methods

Two hundred dominant and codominant crop trees were pruned in a 28-year-old even-aged stand of pure Douglas-fir that came in naturally after logging and slash burning. The stand varied in density from moderate to well-stocked. Site averaged class IV according to McArdle and Meyer's (*7*) site classification.

In 1937 the selected trees ranged in diameter at breast height from 3.2 to 10.5 inches, and in total height from 28 to 59 feet. In 1950 diameter varied from 4.0 to 14.5 inches, and total height ranged from 38 to 90 feet. At the beginning of the experiment, the study trees had dead limbs on the lower bole to an average height of 12.4 feet, which was approximately 30 percent of their total height.

Pruning treatments consisted of the removal of only dead limbs (control) and removal of dead limbs plus 25, 50, and 75 percent of the live crown length. Within a uniform stand, a 200-foot-square study area was divided into four 100-foot-square subplots, each containing either 48 or 52 trees selected for treatment. One of four pruning treatments was assigned by random selection to each tree after the trees had been tagged and measured for d.b.h., total height, and height to the first live limb. Actual height of pruning was governed by the treatment assigned to each tree, its total height, and the height to its first live limb. Pruned length varied from a low of 6 feet (one tree with only dead limbs removed) to a maximum of 44 feet (a tree with 75 percent crown removal).

The first remeasurement of the pruning study was made in 1943, and preliminary results were reported by Isaac (*6*) in 1945. Besides showing that significant differences existed between treatment means, the 1943 analysis demonstrated that there was no significant difference between subplots or significant interaction between subplots and treatments. For purposes of simplifying subsequent analyses, it was therefore considered reasonable to disregard subplots and to assume complete randomization for all trees in the experiment.

The present analysis, using data from the 13-year period 1937-1950, showed that diameter growth was related to initial diameter and height growth to initial height. In both cases the larger trees made the best growth. Growth was therefore corrected for initial diameter and height by an analysis of covariance, and treatment means were adjusted to a common initial diameter and height. The differences between adjusted means were then tested for statistical significance by "t" test. Finally, second-degree polynomial curves were computed that expressed the relation of adjusted diameter and height growth to the amount of live crown removed.

Growth After Pruning

Diameter growth was not reduced by the removal of the lower 25 percent of the live crown length, but it was reduced by removal of 50 and 75 percent. Trees from which 25 percent of the crown was removed increased 6.5 percent more in diameter in 13 years than the control (Table 1). Trees from which 50 and 75 percent of the live crown length was removed grew less in diameter than the control by 8.3 and 53.1 percent respectively.

The effect of pruning on height growth was similar to the effect on diameter growth. Trees from which 25 percent of the live crown length was removed showed a 4.9-percent increase in height growth over the controls, but trees from which 50 and 75 percent was removed showed reductions of 9.2 and 33.6 percent respectively (Table 2).

The average annual diameter growth declined from the 1937-43 period to the 1943-50 period for trees from which 50 percent or less of the live crown was removed, and average annual height growth remained approximately the same (Table 3). Trees from which 75 percent of the crown was removed showed a definite increase in both diameter and height growth for the second period. This is interpreted to mean they were recovering from the physiological shock of the severe pruning. Their growth was still far below normal, however.

TABLE 1.—MEAN DIAMETER AND MEAN DIAMETER GROWTH FOR FOUR DEGREES OF PRUNING

(Based on 192 trees alive in 1950)

Item	Time	Extent of pruning			
		Dead limbs	25% live crown	50% live crown	75% live crown
Number of trees		49	49	45	49
Mean d.b.h., inches	1937	5.48	5.65	5.16	5.59
	1950	7.58	7.95	6.96	6.61
Mean dia. growth, inches	1937-50	2.10	2.30	1.80	1.02
Adjusted mean dia. growth, inches	1937-50	2.10	2.23	1.92	0.98
Dia. growth in percent of dead-limb pruning	1937-50	100.0	106.5	91.7	46.9

TABLE 2.—MEAN TOTAL HEIGHT AND MEAN HEIGHT GROWTH FOR FOUR DEGREES OF PRUNING
(Based on 192 trees alive in 1950)

Item	Time	Extent of pruning			
		Dead limbs	25% live crown	50% live crown	75% live crown
Number of trees		49	49	45	49
Mean total ht., feet	1937	40.6	40.8	39.7	40.9
	1950	60.6	61.8	57.6	54.2
Mean height growth, feet	1937-50	20.0	21.0	17.9	13.3
Adjusted mean ht. growth, feet	1937-50	19.9	20.9	18.1	13.2
Height growth in percent of dead-limb pruning	1937-50	100.0	104.9	90.8	66.4

TABLE 3.—MEAN ANNUAL DIAMETER AND HEIGHT GROWTH, BY PERIODS
(Based on unadjusted measurements of 192 trees alive in 1950)

Extent of pruning	Mean ann. dia. growth		Mean ann. ht. growth	
	1937-43	1943-50	1937-43	1943-50
	Inches		*Feet*	
Dead limbs	0.19	0.14	1.5	1.5
25% live crown	0.20	0.16	1.6	1.6
50% live crown	0.16	0.12	1.3	1.4
75% live crown	0.07	0.08	0.9	1.2

TABLE 4.—SIGNIFICANCE OF DIFFERENCES BETWEEN TREATMENT MEANS (1937-50) BY "t" TEST BASED ON MEANS ADJUSTED FOR INITIAL DIAMETER OR HEIGHT BY COVARIANCE ANALYSIS

Treatments compared	"t" Value	
	Diameter	Height
Dead limbs *vs.* 25%	1.31	1.42
Dead limbs *vs.* 50%	1.60	2.62*
Dead limbs *vs.* 75%	10.61*	9.75*
25% *vs.* 50%	2.86*	4.00*
25% *vs.* 75%	11.93*	11.17*
50% *vs.* 75%	8.71*	6.90*

*All starred values are highly significant ("t" value at 99% level of probability equals 2.60).

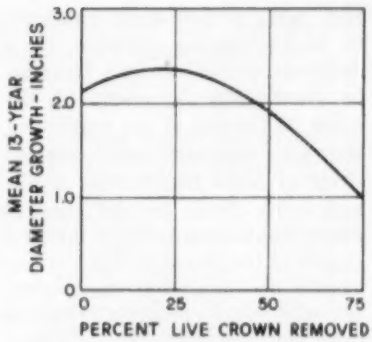

FIG. 1.—Relation of mean diameter growth (1937-50) to percent of live crown removed, adjusted for differences in initial diameters of trees.

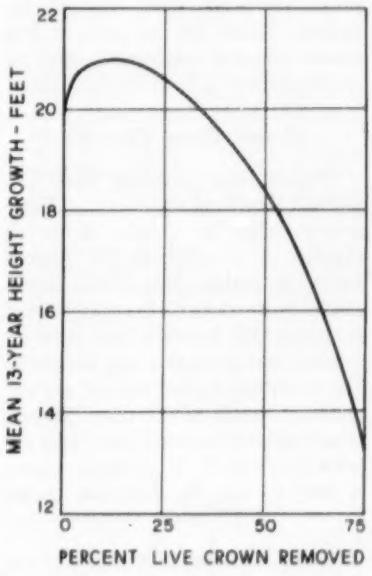

FIG. 2.—Relation of mean height growth (1937-50) to percent of live crown removed, adjusted for differences in initial heights of trees.

Reductions in growth following the 50 and 75 percent pruning treatments were found to be significant by "t" test with one exception (Table 4). Although there was a significant difference at the 5-percent level in diameter growth between dead limb pruning and 50 percent live crown pruning for the period 1937-43 (*5*), there was no significant difference for the period 1937-50. It appears that growth in the second period was better because more normal crown lengths had been attained by the trees subjected to 50 percent live crown pruning.

The intensity of pruning had a more critical effect on height growth than on diameter growth. For the 13-year period, the difference in height growth between dead limb removal and 50-percent live crown removal was highly significant. The corresponding difference in diameter growth was not significant.

Although the tabular data presented thus far show that 25 percent of the live crown can be removed without loss of growth, they do not show the maximum that might be removed without loss. The calculated curves (Figs. 1 and 2) show that up to 38 or 40 percent of the live crown can be removed without loss of diameter or height growth. It is therefore concluded that the removal of the lower one-third of the live crown length is a good, practical, and conservative guide that should not reduce future growth of the pruned trees.

The data presented in Tables 1 and 2 and the curves in Figures 1 and 2 indicate that more growth occurred on the trees where 25 percent of the live crown was pruned than on the trees where only dead limbs were pruned. It is shown (Table 4) that the difference between these treatment means is not significant statistically by "t" test for either diameter or height growth. However, the curves which do indicate this increase are the best mathematical fit of the data. The indication that pruning of the lower 25 percent of the live crown length may have slightly stimulated height and diameter growth leads to an interesting physiological conjecture.

Perhaps the lowest and oldest limbs on a tree constitute a drain on the photosynthate produced by the tree since these limbs have a

high ratio of food-using cambium to food-producing needles. In a moderate or well-stocked Douglas-fir stand 25 or 30 years old, the lower 25 percent of the live crown length is composed mainly or entirely of limbs that receive no direct light. Their prompt removal might eliminate a drain on the food supply of the tree and thus increase growth. To the author's knowledge, the only data in pruning literature indicating this possibility have been presented by Helmers (*3*) for western white pine and the California Forest and Range Experiment Station (*1*) for ponderosa pine. In both cases, the greater growth values for 25 percent live crown removal were small, and no emphasis was placed upon them.

Crown Class Changes

Crown class changes have important practical significance. Trees are pruned to obtain as much growth as possible on the cleared boles. In many parts of the Douglas-fir region, early thinning is not economically feasible, and it is essential that trees selected for pruning maintain a good rate of growth without benefit of thinning. Hence, dominant and codominant trees are usually pruned. If pruning causes a tree to lose its desirable crown position to neighboring unpruned trees, however, time and money have been wasted.

Loss of crown position in the canopy is constantly taking place as well-stocked stands grow. Thirteen trees in both the dead limb removal and 25 percent live crown removal treatments dropped back one class in crown position in 13 years, apparently a normal amount of change (Table 5). In contrast, 23 dropped back one or more crown classes after 50 percent live crown removal, and 33 following 75 percent live crown removal. These last two treatments must therefore be considered too severe.

Mortality, Injury, and Decay

Eight pruned trees died in the years 1937-50; five during the second remeasurement period. In no case, however, can the death be attributed directly to the effects of pruning. One tree was killed through breakage caused by wet snow (*5*). Several others died as the result of *Poria weirii* root rot. Five of the dead trees occurred in the group with 50 percent live crown removed; one tree died in each of the other treatment groups.

Sunscald injury and epicormic branching were greater on the heavily pruned trees (Table 6). Sunscald was more noticeable in 1943 than in 1940; no additional sunscald injury was observed in 1950. Epicormic sprouts formed for only a year or two after pruning, and branches developed from the sprouts only in the group having 75 percent live crown removed. By 1950, most of the trees had dead limbs above the height to which they were pruned.

A number of trees adjacent to the study plot boundaries were given the same crown removal treatments as the trees on the plot. Some of these trees have been dissected by the Division of Forest Disease Research at periodic intervals. No decay has been found under pruning wounds; many of the scars are now completely overgrown, and the trees have begun to put on clear wood.

Application of Results

Selection of the correct pruning height is dependent upon both the effect of pruning on the tree and the cost of pruning to a given height. The data of this study indicate that one-third of the live crown length may be removed without causing growth reduction or other undesirable effects. This pruning height is also a practical one from the viewpoint of pruning costs and benefits.

Pruning for this study was done in 1937 by a CCC crew using hand and pole saws. The highest limbs were reached by climbing the trees. It required an average actual pruning time of 12.0, 15.6, 18.6, and 25.2 minutes per tree to prune dead limbs only and dead limbs plus 25, 50 and 75 percent of the live crown length respectively (*4*).

The removal of 25 percent of the live crown gave a clear bole length ranging from 12 feet to 32 feet, with an average of 19.6 feet. Dead limb pruning resulted in a range of clear bole length from 6 feet to 22 feet, averaging 12.6 feet. The average clear bole length for 50-percent live crown pruning was 26.2 feet, and for 75 percent pruning it was 33.5 feet. Removal of 25 percent of the live crown length

TABLE 5.—NUMBER AND PERCENT OF TREES BY CROWN CLASSES IN 1937 AND 1950 FOR EACH PRUNING TREATMENT[a]

Extent of pruning	Year	No. live trees	Crown classes: Dom. No.	Dom. %	Codom. No.	Codom. %	Int. No.	Int. %	Sup. No.	Sup. %	Total no. changes
Dead limb	1937	50	34	68	16	32	0	0	0	0	
	1950	49	24	49	22	45	3	6	0	0	
25% live crown	1937	50	40	80	10	20	0	0	0	0	13
	1950	49	30	61	15	31	4	8	0	0	13
50% live crown	1937	50	42	84	8	16	0	0	0	0	
	1950	45	17	38	24	53	4	9	0	0	23
75% live crown	1937	50	39	78	11	22	0	0	0	0	
	1950	49	14	29	22	45	10	20	3	6	23

[a] Trees moving upward in crown class are not included. Only three trees improved in crown position; two in the dead limb treatment, one in the 25% pruned group.

TABLE 6.—SUNSCALD INJURY AND EPICORMIC BRANCHING FOR EACH PRUNING TREATMENT IN 1940 AND 1943 (*5*)

Extent of pruning	Percent of trees with epicormic branches: 1940	1943	Percent of trees with sunscald: 1940	1943
Dead limbs	0	0	0	0
25% live crown	4	2	2	2
50% live crown	27	0	2	12
75% live crown	72	15	24	33

gave, on the average, a clear butt log of 18 feet with an occasional one 24 feet or longer.

Pruning 25 percent of the live crown length required a low expenditure of time per tree (15.6 minutes). The removal of dead limbs only required the least time (12.0 minutes), but this degree of pruning did not yield the most desirable length of clear log. Pruning 50 and 75 percent of the live crown not only resulted in reduced growth, but also required a greater pruning investment for the amount of clear wood obtained (18.6 and 25.2 minutes respectively).

Summary

A 13-year record of growth following four degrees of pruning in a 28-year-old Douglas-fir stand on site quality IV is presented and analyzed. Removing the lower 25 percent of the live crown length did not reduce diameter or height growth, and may have even stimulated growth slightly. Following 25 percent removal, sunscald and epicormic branching were not serious, and clear stems averaging 19.6 feet in height were obtained.

Removing 50 percent or more of the live crown length caused progressively greater reductions in both diameter and height growth and accelerated loss in crown class as the heavily pruned trees failed to maintain their original positions in the stand. Epicormic branching and sunscald damage also increased with severity of pruning.

For all pruning treatments, most wounds healed over in 13 years, and there was no evidence that decay had entered the stem through pruning wounds.

It is concluded that for Douglas-fir stands of similar site and age, one-third of the length of the live crown can be removed without causing important reductions in height or diameter growth, serious changes in crown class, sunscald injury, or epicormic branching. Substantially the same conclusions have been reached by other studies with other species, as Dahms (*2*) for ponderosa pine and Helmers (*3*) for western white pine.

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SOCIETY OF AMERICAN FORESTERS

55TH ANNUAL MEETING

Portland, Oregon. Multnomah Hotel

October 16-19, 1955

See the June issue of the JOURNAL *for information concerning the schedule of events, hotel reservations, and committees for the meeting.*

The Effect of Oak Wilt on the Cold-Soak Treatability of Oak Fence Posts

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ANY DEVELOPMENT which affects the passage of liquids through wood also affects the treatability with wood-preservative solutions, especially when the method of preservative application is by cold-soaking. The plugging of xylon vessels of the red oak group by tyloses as a result of infection by the oak wilt fungus (*Endoconidiophora fagacearum* Bretz) has been reported by Beckman *et al* (*2*). The present study was initiated by the Illinois Natural History Survey and the Illinois Agricultural Experiment Station to determine what effect oak wilt has on the treatability of posts of the red oak group.

Although most species of the red oak group are naturally free from tyloses, tyloses are commonly found in trees of the white oak group.[3] Tyloses may develop as the sapwood vessels are being transformed into heartwood (*3*). In trees killed by oak wilt, however, the tyloses are formed in the vessels of the outer few rings of the sapwood (*2*). From the standpoint of treatability of woods of the red oak group, their development is of interest mainly if the cold-soak method is to be employed for the treatment of round products.

Materials and Methods

Forty-five round posts ranging from 6.4 to 7.4 feet in length and with midpoint diameters ranging from 2.7 to 7.1 inches were cut from the trunks or limbs of red oaks (*Quercus rubra* L.) and black oaks (*Q. velutina* Lam.) in the spring and early summer of 1953. One-third of the posts were obtained from trees which wilted in 1952; one-third were cut from trees which wilted in 1953; and one-third came from healthy trees.

All posts were cut, peeled, and stacked for air-seasoning by early July, 1953. The posts cut from trees which wilted in 1952 and the control posts were seasoned five months; those cut from trees which wilted in 1953 were seasoned three months. Although seasoning conditions were exceptionally good during this period, the additional precautionary measure of covering the posts with a tarpaulin at night and uncovering them throughout the day was used during the last two weeks of the seasoning period.

The length of each post was recorded to the nearest 0.1 foot, and the diameter was measured at the approximate midpoint of each post to the nearest 0.1 inch with a diameter tape. Post volumes in cubic feet were determined by the formula BL, in which B is the area in square feet of a circle having a diameter equal to the midpoint diameter, and L is the length of the post in feet.

Immediately before treatment was begun, the midpoint moisture content of each post was determined at a measured radial depth of 0.5 inch with an electrical resistance-type moisture meter.

Each post was weighed to the nearest 0.01 pound before and after being soaked 48 hours, and its absorption of preservative solution in pounds per cubic foot was computed to the nearest 0.1 pound. The posts were cold-soaked for 48 hours in a vertical position, butts downward, in a No. 2 fuel oil pentachlorophenol solution. The toxicant concentration of the solution was 5 percent of the solution weight. The posts were submerged in the treating solution so that approximately 12 inches of liquid covered their top ends.

Depth of solution penetration and thickness of sapwood were measured about 16 hours after treatment on five posts selected at random from each of the three test groups. An inch-thick cross-section cut from the midpoint of each of these posts was split along the grain on the diameter. Sapwood thickness and depth of sapwood penetrated by the solution were measured on the freshly split surface to the nearest 0.01 inch. Since some difficulty was experienced in determining the depth of penetration by the color imparted by the preservative solution, the Sandermann-Jonas methyl-violet technique (*5*) was used as a check on the field measurements. Approximately 80 hours elapsed between the first and second measurements. A Student's "t" test showed no significant difference between the means for the two methods and the within-group variances were tested and found to be homogeneous. The data obtained by the two methods were averaged, and the averages were used as a basis for computing the percent of sapwood treated.

The 30 posts not used for sampling penetration were randomized and set in fence lines to determine the decay resistance of untreated posts cut from wilted trees and the effectiveness of the preservative treatment.

Results

Table 1 shows for each group the average sizes of the posts, the average amount of solution absorbed, and the average depth in which the solution penetrated the sapwood. Table 2 presents an analysis of variance for the solution-absorption data, and Table 3 is an anal-

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[2] The authors wish to acknowledge with thanks the contributions made to this study by the following agencies:

The Delmhorst Instrument Company, Boonton, N. J., for the use of a Model RC-1 moisture detector; Sinnissippi Forest, Inc., Oregon, Ill., for the use of its treating plant and for the posts cut from the Forest; and the Peoria Park District, Peoria, Ill., for posts cut from its parks.

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[3] A very few species of the red oak group contain tyloses; chestnut oak, a member of the white oak group, has very few tyloses.

TABLE 1.—THE SIZE, MOISTURE CONTENT, AND RESULTS OF COLD-SOAKING BLACK OAK FENCE POSTS IN A FUEL OIL—PENTACHLOROPHENOL SOLUTION

Post group	Average size		Average volume, cu. ft.	Average moisture content, pct.[1]	Solution absorption			Average penetration of sapwood by solution[2]			
	Midpoint diameter, in.	Length, ft.			Average, lb./cu. ft.	Standard error, lb.	Based on oil discoloration, in.	Methyl-violet test, in.	Average, in.	Standard error, in.	Pct.[3]
Wilted 1952	4.6	7.1	0.863	13.4	2.8	0.4	0.31	0.35	0.32	0.04	91
Wilted 1953	5.2	7.0	1.061	14.4	2.9	0.3	0.48	0.45	0.46	0.06	96
Unwilted controls	4.7	6.9	0.867	12.9	4.1	0.2	0.23	0.29	0.26	0.04	70

[1]Determined at radial depth of ½-inch with electrical resistance-type moisture meter.
[2]Measurements based on oil discoloration made 16 hours after treatment; methyl-violet test made 96 hours after treatment.
[3]Based on average of two methods of measurement and average sapwood thickness.

ysis of variance for solution-penetration data.

The average absorption for the control posts was 4.1[4] pounds per cubic foot, whereas the absorption for the wilted posts was 2.8 pounds, or only 68 percent of that for the controls. The difference in absorption also is shown in the analysis of variance (Table 2) by the highly significant between-group variation. The absorption variation due to wilt was responsible for practically all of the between-group variation.

The standard errors in pound of solution for the three groups were 0.2 for the control posts, 0.3 for the posts wilted in 1953, and 0.4 for those wilted in 1952. These data indicate that the absorption for the control posts was the least erratic of the three groups and that the longer dead from wilt the more erratic absorption became. In other words, the wilted posts took the treatment less uniformly than did the healthy posts when compared on the basis of solution absorption.

The average depths of solution penetration were: controls, 0.26 inch; wilted 1952, 0.32 inch; and wilted 1953, 0.46 inch (Table 1). The standard errors for the three groups were controls, 0.04 inch; wilted 1952, 0.04 inch; and wilted 1953, 0.06 inch. Table 3 shows the between-group[5] variation to be significant at the 5-percent level, and that most of the variation was due to wilt.

TABLE 2.—ANALYSIS OF VARIANCE FOR SOLUTION ABSORPTION DATA

Source of variation	Degrees of freedom	Sum of squares	Mean squares	Variance ratio (F)
Between groups	2	10.58	5.3	6.6**
Wilt	(1)	10.42	10.4	13.0**
Within groups	27	21.37	0.8	
Total	29	31.95		

**Highly significant, or significant at 1 percent point.

TABLE 3.—ANALYSIS OF VARIANCE FOR SOLUTION PENETRATION DATA

Source of variation	Degrees of freedom	Sum of squares	Mean square	Variance ratio (F)
Between groups	2	.2086	.1043	4.1*
Wilt	(1)	.1215	.1215	4.8*
Within groups	27	.6897	.0255	
Total	29	.8983		

*Significant at 5 percent point.

The average depths to which the solution penetrated the sapwood corresponded quite closely for the two methods of measurement, although measurements for individual posts sometimes ranged widely. Since the measurements were taken at different points on the sample disk and at different times, one might expect such differences. The average depth of penetration for two of the three groups was found to be deeper by the methyl-violet test. This result is probably due to solution creep, since 80 hours elapsed between the making of the two measurements.

The average thickness of sapwood was 0.41 inch, ranging from 0.25 to 0.60 inch. The average amount of sapwood penetrated was 70 percent for the control group and above 90 percent for both groups of wilted posts.

Several untreated spots were found within the treated areas of wilted posts,[6] whereas none were observed in the treated parts of the control posts. These untreated spots varied in size, but were generally less than 0.1 inch across the grain where viewed on a radial surface. No measurements were made to determine their length along the grain.

Discussion and Conclusions

Tyloses formation is the only established morphological difference between the outer sapwood of

[4]The American Wood-Preservers' Association (*1*) specifies an absorption of 6 pounds of creosote per cubic foot of post as a commercial standard. Laboratory experiments and general experience have indicated that a pentachlorophenol solution such as the one used in these tests can be used in about the same retentions as creosote for decay prevention. Compared to other post-treating tests conducted by the Illinois Agricultural Experiment Station, in which oak posts were treated by methods essentially the same as those used in the above-described tests, the absorption obtained for the control posts were exceptionally good.

[5]Since statistical tests showed no significant difference in the data obtained by the two methods of measurement, they were pooled for the analysis.

[6]The American Wood-Preservers' Association specifies (*1*) that ". . . no untreated bands of one or more annual growth rings . . ." are to be included in the measured distance penetrated by the preservative. Although the measurements made in these tests followed the specification, the measurements represent the conditions which were found in a rather limited area.

wilt-killed and healthy trees of the red oak group. Since the total absorption of preservative was significantly less in wilt-killed posts, it is concluded that tyloses lowered the total absorption of preservative. This conclusion is strengthened by the fact that the difficulty in treating white oak is attributed to vessel plugging by tyloses (*4*).

The variation in depth of solution penetration (Tables 1 and 3) has been attributed to the wilt fungus. Why the solution penetrated more deeply into the wilted posts than into the ones cut from healthy trees is not known. Perhaps the deeper penetration was due to the presence of tyloses in the sapwood. The deeper penetration may have been caused by the preservative by-passing the tyloses and penetrating more deeply through normal channels of flow, by an increased rate of flow due to a reduction in void space caused by the tyloses, or by unknown physical-pathological changes brought about by the fungus.

The occurrence of small untreated zones in the sapwood would suggest that the preservative bypassed (at least temporarily) a plugged area.

The standard errors (Table 1) indicate that the penetrations obtained in the posts cut from trees which wilted in 1953 were the most erratic. The erratic nature of the penetration may be due to an irregular distribution of the tyloses.

The lower absorptive capacity of the wilt-killed posts is of interest to persons treating posts by the cold-soak method. From a practical point of view, a longer treating period probably should be used for posts cut from wilt-killed trees. The Illinois Agricultural Experiment Station currently recommends a soaking period of 48 hours for treating posts of the red oak group (*6*). Extension of the treating period from 48 to 72 hours may be helpful in overcoming the inhibiting effect which oak wilt has on the absorption of an oil solution of pentachlorophenol.

Summary

Forty-five round, black oak and red oak fence posts, 15 cut from trees which died in 1952, 15 from trees which died in 1953 of oak wilt, and 15 from healthy trees, were air-seasoned and then cold-soaked for 48 hours in a fuel oil–pentachlorophenol solution. The absorption of solution and depth to which the preservative liquid penetrated the wood were measured.

The average absorption of solution by the posts from healthy trees was 4.1 pounds per cubic foot, whereas the posts from wilted oaks absorbed 2.8 pounds per cubic foot, or only 68 percent of that for the controls. The standard errors for the three groups indicated that the absorption data for the control posts were less erratic than were data for the group of posts cut from trees which wilted in 1952 or those cut from trees which wilted in 1953.

Seventy percent of the sapwood of the control posts was penetrated by the preservative solution. The two groups of wilted posts, however, showed an average sapwood penetration of at least 91 percent of the sapwood. Penetration data for treated posts showed that the treatment of the sapwood of wilted posts was more erratic than that of the control posts. Small untreated spots were scattered throughout the treated sapwood of sample posts from the two wilted groups, but they were not observed in samples from the control group.

The authors conclude:

1. That oak wilt has an inhibiting effect on solution absorption by round red oak and black oak fence posts treated by the cold-soak method. The inhibiting effect is believed to be due to the presence of tyloses in the sapwood of trees killed by the oak wilt fungus.

2. Fence posts taken from oak wilt-killed timber and treated by the cold-soak method should undergo a longer period of treatment than is ordinarily recommended for oak posts treated by this method. A period of 72 hours is suggested.

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The European Pine Sawfly on the Henderson State Forest, Illinois, with Notes on Its Biology and Control

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THE EUROPEAN pine sawfly, *Neodiprion sertifer* (Geoff.), is a recent introduction into the United States from Europe. It was reported in Illinois initially in 1950 when outbreak numbers of larvae were observed in a pole sized hard pine plantation on the Henderson State Forest near Oquawka. Inasmuch as this sawfly is a serious pest of pines in Europe and in eastern North America, a reconnaissance survey of the Henderson State Forest was conducted to determine the extent and seriousness of the infestation so plans could be formulated for its control. Cooperating in this program were the Illinois State Division of Forestry, the Illinois Natural History Survey, and the U. S. Bureau of Entomology and Plant Quarantine. Reported herein are the results of the survey and subsequent control activities. Biological and ecological information relative to the sawfly, obtained in conjunction with the program, is summarized.

History of Introduction and Spread

The European pine sawfly was first observed in the United States in 1925 when larvae were found in abundance on hard pines near Somerville, New Jersey (*6*). By 1937 it had become distributed throughout the northern counties of the state. Its spread westward was signaled by its appearance in Ohio in 1937, reported by the late J. S. Houser, and in Michigan in 1938 (*5*). In 1939 it was detected at Windsor, Ontario (*3*). Severe outbreaks occurred in northern Indiana in 1952 and 1953, and a single collection in Urbana, Illinois in 1951 was reported by H. H. Ross. Intensive surveys of the Urbana-Champaign area conducted by the Illinois Natural History Survey indicates that this infestation has died out. The appearance of the sawfly on the Henderson forest represents an extension of its range to the Mississippi River.

Biological and Ecological Observations

Adult European pine sawflies emerge from their cocoons in Illinois in September and October. Mating occurs and the eggs are laid in current season's needles well toward the tips of the upper branches. These eggs overwinter and first instar larvae hatch during the last week of April and early May. Hatching coincides roughly with the peak of eastern redbud, *Cercis canadensis* L., bloom.

Larval feeding progresses rapidly and is restricted to the previous season's needles. Early instar larvae feed primarily on the edges of the needles; the later instar larvae consume the entire needle. Cocooning occurs in the litter and duff beneath infested trees in early June. A single generation per year occurs.

Ovipositing females exhibit a pronounced preference for Japanese red pine, *Pinus densiflora* Sieb. & Zucc., over other pine species present on the Henderson Forest. Red pine, *P. resinosa* Ait., was selected next; other species were attacked less frequently. The sawfly laid from 32 to 94 eggs per batch and from 1 to 19 eggs per needle (Table 1). When eggs were laid on pitch pine, *P. rigida* Mill., severe injury to the needle resulted and these needles dried and fell within 60 days, with the result that the eggs failed to hatch (Fig. 1). Pitch pine thus actually served to absorb some of the sawfly population. Twenty virgin females were dissected and contained an average of 76.9 $\pm$ 6.26 eggs with a range of 63 to 91.

Among the entomophagous insects associated with the sawfly were the larval predator, *Podisus placidus* Uhler, and *Exenterus*

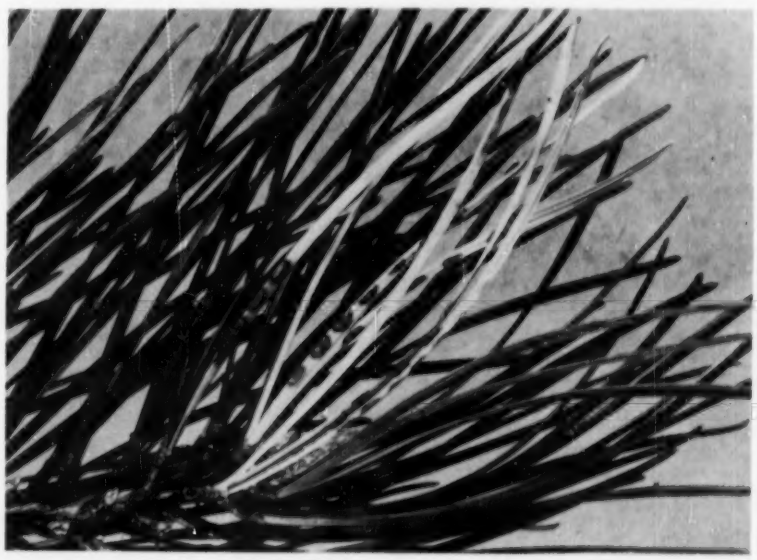

FIG. 1.—Pitch pine needles injured by oviposition of European pine sawfly.

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[3]Illinois State Division of Forestry.

canadensis Prov.; the latter was reared from cocooned larvae.

Reconnaissance Surveys

The Henderson Forest, situated 190 miles southwest of Chicago on the east banks of the Mississippi River 18 miles upstream from Burlington, Iowa, is outside of the normal range of both northern and southern hard pines. Included within the forest boundaries are approximately 1,047 acres, 350 of which have been planted with exotic and domestic pines. Adjacent to the forest are 40 acres of privately owned red pine plantations.

Reconnaissance surveys conducted in June 1950 indicated that 28 acres within the forest and the adjacent private plantations were infested. In November, sawfly eggs were found on hard pines scattered throughout the entire forest. Since both new and empty cocoons were collected in abundance in early 1950, it is believed that the infestation on the Henderson Forest had been present for several years.

Control Projects

To reduce damage being caused by the sawfly and to prevent its possible further spread, a control program was undertaken in the spring of 1951. Responsibility for the administration of the control project, procurement of supplies and equipment, and for delineation of the areas to be treated was assumed by the Illinois Forestry Division. Technical advice was given and post-spray evaluation was made by the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

Larval feeding activity occurs over a rather short period after emergence from the overwintering eggs and for this reason serious consideration was given to the proper timing of spraying. Sawfly egg collections were examined biweekly until hatching occurred and spraying was scheduled to begin after the completion of hatching of all eggs. It was May 15 by this time and the majority of the larvae were in the second and third instars. The initiation of spraying coincided with phenological development to the degree shown in Table 2.

Aerial control project. — DDT sprays made up from a stock 25 percent DDT emulsion concentrate, diluted to 12½ percent with fuel oil were applied at the rate of one gallon per acre throughout the aerial control project. A Stearman airplane equipped with 18 B-5 nozzles was used to apply the spray over 66 foot swaths. All spraying was conducted at 25 to 50 feet above tree tops; wind velocities were below 1 m.p.h. Inclement weather and equipment failures delayed the completion of spraying of the 66 acres of infested plantations until May 17. Wet foliage conditions existed and a light rain fell three hours after spraying.

Hand spraying project.—Champion knapsack sprayers equipped with mist-producing nozzles rated at 2.6 gallons per hour were used for treating several plantations containing an aggregate of 103 acres of heavily infested pines. These blocks were considered too small to be economically sprayed by aerial equipment and were treated with a 3 percent DDT emulsion-oil solution at the rate of approximately one gallon per acre. No attempt was made to spray infested trees only, all trees were treated as the operator walked between the rows of pines.

Results.—Evaluation of the control obtained was delayed 48 hours to allow maximum effect of the insecticide. A series of pines was examined in several plantations treated from the air and from the ground taking samples at right angles to the direction of flight and parallel to the operators path in the two respective treatment areas. Trees having evidence of current sawfly defoliation only, and trees on which a few scattered larvae remained as a disorganized colony, were classified as "kill." "Intact" colonies were those containing an organized feeding larval colony.

Although this sawfly is easily killed by DDT, the control obtained was quite poor; on the areas sprayed from the air the population reduction ranged from 59 to 89 percent, on the hand sprayed areas from 66 to 88 percent (Table 3). For the forest as a whole, the overall population reduction was 73 percent. This degree of control was unsatisfactory as large numbers of larvae completed development and spun cocoons. The inclement weather that occurred during the spraying undoubtedly had

TABLE 1.—FECUNDITY OF EUROPEAN PINE SAWFLY ON HENDERSON STATE FOREST, OQUAWKA, ILLINOIS

	Egg batches examined	Eggs per female	Eggs per needle Average	Range
Pinus densiflora Sieb. & Zucc.	15	94.5 ± 6.6	9.8	2–16
P. resinosa Ait.	15	80.9 ± 7.1	8.9	2–19
P. ponderosa Laws.	12	60.5 ± 13.5	10.2	1–16
P. rigida Mill.	6	35.2 ± 2.9	6.6	3–11
P. echinata Mill.	1	32.0	8.0	7– 9
P. banksiana Lamb.[1]				
P. contorta var. *latifolia* Engelm[1]				

[1]Small number of larvae observed feeding; eggs were not collected.

TABLE 2.—PHENOLOGICAL DEVELOPMENT AT INITIATION OF SPRAYING

Species	Terminal elongation	Staminate flowers	Pistillate flowers
Pinus banksiana Lamb.	3 to 8 inches	Pollen fall complete	
P. densiflora Sieb. & Zucc.	3 to 8 inches	Pollen falling	Tips red
P. ponderosa Laws.	3 to 5 inches	None	
P. resinosa Ait.	3 to 5 inches	None	
P. rigida Mill.	3 to 5 inches	Pollen falling	Tips red
P. virginiana Mill.	3 to 8 inches	Pollen falling	
Carya cordiformis (Wangenh.) K. Koch		Buds open and leaves unfolding.	
Cercis canadensis L.		Bloom complete and petals falling.	
Prunus americana Marsh.		Bloom complete and petals falling.	
Quercus marilandica Muenchh.		Catkins falling.	

some influence on the success of the operation. In the fall of 1951, sawfly eggs were abundant throughout both the sprayed and nonsprayed plantations.

Virus Disseminations

In May 1952 a small quantity of a disease causing virus concentrate was obtained from the New Haven laboratory of the U. S. Bureau of Entomology and Plant Quarantine for introduction into the Henderson Forest sawfly infestation. Originally discovered in Europe, this virus had been disseminated with striking success in Canada in 1950 and 1951, and in New Jersey in 1951 (*1, 2, 4*). The virus concentrate used on the Henderson Forest was reisolated and concentrated from the latter area.

On May 9, three plantations aggregating 11 acres of mixed Japanese red pine, *Pinus densiflora* Sieb. & Zucc., and red pine, *P. resinosa* Ait., were sprayed with a well-water suspension containing approximately 1,872,000 virus polyhedral bodies per gallon of suspension at the rate of 1.8 gallons of spray per acre. Knapsack sprayers equipped with mist-producing nozzles rated at 2.6 gallons per hour were employed to drift the spray through the pine foliage. No attempt was made to treat only infested trees; all pines within the tract were sprayed. Foliage was dry at the time of treatment, but the sky was overcast and wind velocity was 0 to 1 m.p.h. A light rain fell two hours after treatment. The sawfly larvae were in the second and third instars.

On May 10 a 2-acre block of Japanese red and red pine within a 40-acre plantation was treated with the virus concentrate suspension. This area was to serve as a locus of infection for studies of the spread of the infection to adjacent areas, and for overwintering survival tests. Overcast skies and 5 to 8 m.p.h. winds prevailed. Although the foliage was dry at the start of treatment, rain fell during the latter part of the spraying.

Results.—In the 11-acre tract, 45 sawfly infested pines were tagged and the number of sawfly colonies recorded prior to treatment. These pines were examined periodically following spraying for evidence of colony disintegration and larval mortality. The disease did not become apparent until May 15, 6 days after treatment, when 47 to 52 percent of the larval colonies had disintegrated or were absent (Table 4). By May 28, 19 days after treatment, control averaged 96 percent. No reduction in colonies in the nontreated plantations was observed until the first week of June when cocooning began naturally.

In May 1953, 3 by 5 foot cloth mats were placed beneath selected trees within the treated 2-acre tract, at its edge and at the following distances from the tract in westerly, southerly, and northerly directions: 33, 66, 132, 198, 264, and 330 feet. The eastern boundary of the tract lay in an area of heavy oak overstory considered unsuitable for the study. Larvae falling onto the cloth mats were collected in well water where they were allowed to disintegrate prior to transmittal to the Laboratory of Insect Pathology, Sault Ste. Marie, Ontario.[4]

The virus overwintered in the sawfly population satisfactorily and diseased colonies were observed within the tract and up to 264 feet south from the treated area (Table 5). No significant differences in direction of disease spread were apparent. Within the treated tract 15 trees examined at random contained an average of 6.3 diseased colonies similar to that illustrated in Figure 2. In the treated plantations comprising 11 acres, two diseased colonies were observed among 53 colonies examined. Polyhedral bodies were present in all dead larvae collected on pine needles; all collections of healthy appearing larvae both within and outside the treated areas were negative.

Summary

The European pine sawfly, recently introduced into the United States and Canada from Europe, made its initial appearance in Illinois near Oquawka, in 1950. Reconnaissance surveys conducted in

[4]The writers are indebted to Drs. J. MacBain Cameron, F. T. Bird, and to members of the staff for examining and diagnosing all larval material.

TABLE 3.—MORTALITY OF EUROPEAN PINE SAWFLY RESULTING FROM DDT SPRAYS APPLIED BY AIRPLANE AND HAND SPRAYER ON HENDERSON STATE FOREST, ILLINOIS, 1951

Method of treatment	Tract	Acreage	Trees examined	Number of sawfly colonies			Colony mortality
				Total	Intact	Killed	
Airplane							*Percent*
Henderson	A	7	25	36	4	32	89
Henderson	B	7	25	53	9	44	83
Henderson	C	40	50	96	32	64	67
Henderson	D	40	30	54	22	32	59
Hand sprayer							
Henderson	E	3	25	34	4	30	88
Private		1	25	56	19	37	66

TABLE 4.—MORTALITY OF EUROPEAN PINE SAWFLY RESULTING FROM DISSEMINATION OF VIRUS BY HAND SPRAYER ON HENDERSON STATE FOREST, ILLINOIS, 1952

Tract	Total	Number of sawfly colonies			Colony mortality
		Intact	Disintegrated	Absent	
					Percent
			May 15		
Private	95	46	45	4	52
Henderson A	34	18	9	7	47
Henderson B					
			May 26		
Private	95	22	15	58	77
Henderson A	34	3	8	23	91
Henderson B	22	6	14	2	73
			May 28		
Private	95	4	5	86	96
Henderson A	34	0	0	34	100
Henderson B	22	4	2	16	82

FIG. 2.—European pine sawfly killed by virus disease.

1950 and 1951 indicated that the sawfly was restricted to the Henderson State Forest and an adjacent private plantation. Control projects employing aerial and knapsack sprayers to dispense DDT sprays are discussed and the results of virus disseminations summarized. Biological information obtained in conjunction with the surveys and control projects includes life history, host preference, and fecundity information. Two entomophagous associates of the sawfly are listed.

TABLE 5.—DISTRIBUTION OF VIRUS INFECTION FOLLOWING OVERWINTERING IN EUROPEAN PINE SAWFLY, HENDERSON STATE FOREST, ILLINOIS, 1953

Distance from treated tract	Number of collections	Larval collections containing Polyhedra
Within treated area	4	1
At edge of area	3	3
33 feet from area	3	2
66 feet from area	3	1
132 feet from area	3	1
198 feet from area	3	1
264 feet from area	3	1
330 feet from area	3	0

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Black Walnut Responds to Pruning

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PRUNING to improve the quality of wood in black walnut (*Juglans nigra* L.) could be done with greater confidence if information were available on the effects of pruning on this species. Results of a study designed to obtain such information show the effects of pruning on growth, decay hazard, and sprouting.

Much experimental pruning has been done on conifers but very little on hardwoods, particularly black walnut. High-quality walnut is one of our most valuable native woods. Therefore, pruning to increase the quality of walnut timber has good possibilities for a high return on the investment.

In January 1950 a study[2] was begun to find out some of the ways that pruning affects young black walnut trees. The study is being made in parts of 2,000 acres of pure plantations of black walnut on partially graded strip-mined lands in southeastern Kansas. The trees grew from seed planted by the Civilian Conservation Corps during the period 1934 to 1937. Since walnut is a valuable species, it is reasonable to assume that the acreage of walnut planted on strip-mined lands and other areas will increase. Much of the information obtained in this study should also be applicable to walnut in natural stands.

The quality of wood produced in the trees is being lowered by branches and stubs (Fig. 1-A). These are usually more numerous on walnut trees in fairly open stands and in pure plantations than on trees in more dense, mixed stands. In the denser portions of the planted stands, now 17 to 20 years old, the crowns were closed and some of the lower branches were dead. Unfortunately, these dead branches often persist for years. If the lower branches and stubs can be removed by pruning without serious adverse effects, clear wood will be produced at an earlier age and the amount of high-quality wood in the trees at harvest will be increased.

720 Trees Studied

The two main variables in the study are tree size and pruning intensity. The tree-size classes were: 3, 4, and 5 inches in diameter at breast height. The pruning intensities are 75, 50, and 25 percent removal of the live crown and check (unpruned) (Fig. 1).

In order to develop a method for estimating the percent of live crown to be removed, several trees were cut during the growing season and the distribution of their leaf area was analyzed. The leaf area beyond the point where branches are one-half inch in diameter was found to be about equal for different branches. This leaf area was con-

[1]Maintained in cooperation with the University of Missouri Agricultural Experiment Station, Columbia, Missouri.

[2]The study was made in cooperation with the American Walnut Manufacturers Association and the Kansas Forestry, Fish, and Game Commission.

sidered one unit of crown. By following each branch and side branch out to where the diameter was one-half inch, the total number of such units was obtained for each tree. The percent of branches corresponding to the assigned pruning intensity was removed, along with all dead branches.

The study was made in two areas selected for uniformity and proper distribution of tree size classes. When the study was begun the trees were 14 years old and had an average stocking of 500 to 600 trees per acre. Almost one-fourth of the trees in the stands were pruned.

Thirty trees of each size class on each area were selected at random for each of the four pruning intensities. Hence, a total of 720 trees are being considered in this study.

Total tree heights for the 3-, 4-, and 5-inch d.b.h. trees averaged 20.7 feet, 24.3 feet, and 26.2 feet, respectively (Table 1). Before treatment the height to the first dead branch (clear length) averaged 2.0 feet for all diameter classes while the height to the lowest living branch averaged 5.5 feet. This means that the quality of wood on a 3.5-foot section of the bole was being lowered by persistent dead branches.

Removing 25 percent of the live crown cleared the main stems to an average of about 9 feet or 38 percent of the average total tree height of 23.7 feet. Removing 50 and 75 percent of the live crown increased the cleared length to about 11 and 14 feet respectively or 46 and 60 percent of the total height. Hence, increasing the amount of crown removed from 25 to 75 percent cleared only an additional 5.2 feet or 22 percent of the stem.

2-Year Results Are Encouraging

All study trees were remeasured at the end of two growing seasons. Growth data for a 2-year period do not reveal the full effect of pruning or do not form a basis for practical pruning recommendations. However, the data show trends in growth that may help in predicting limits of pruning intensity. The actual differences in growth due to pruning are small, but many of them are statistically significant. These differences in growth are of interest and value from a physiological standpoint. Data on the amount of sprouting that has occurred on pruned trees are considered to be of even more value at this time because this factor will change little after the first two years.

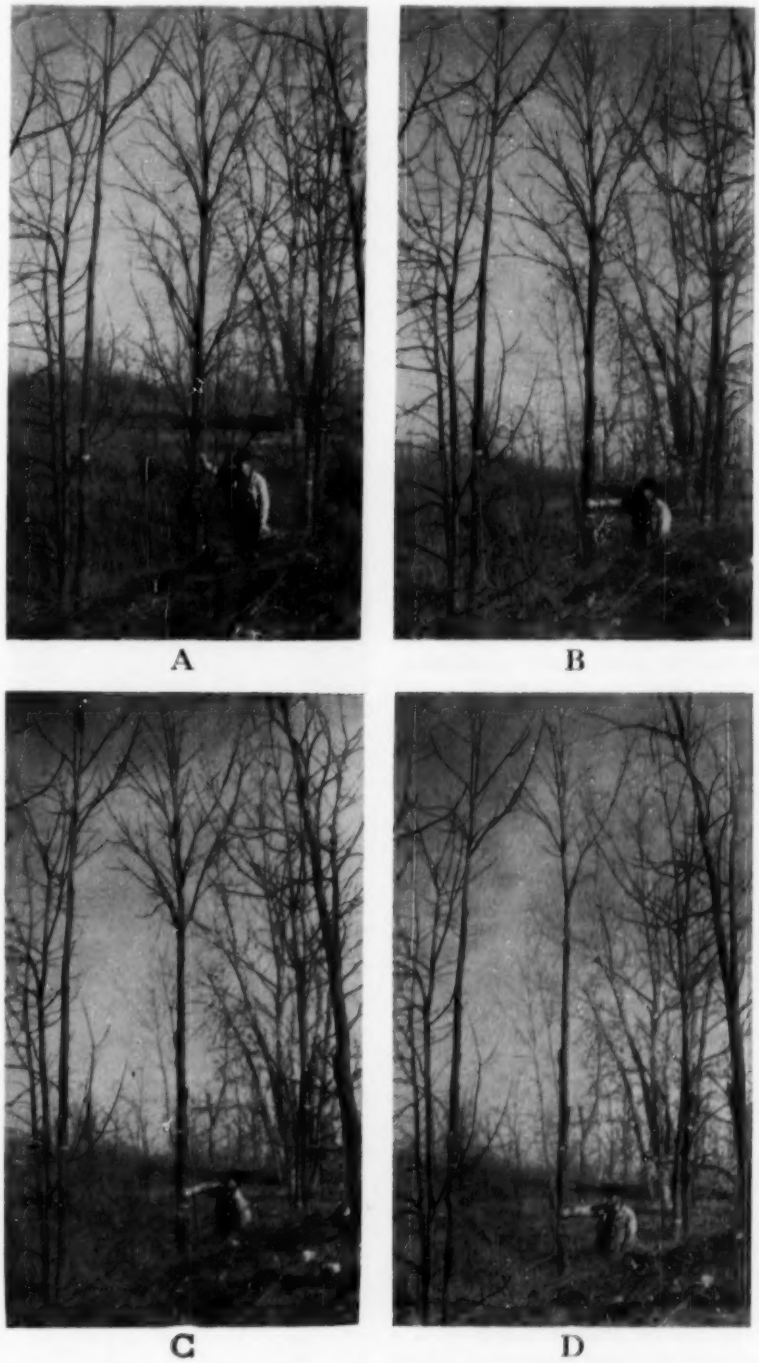

FIG. 1.—At the time of pruning this codominant tree was 5.40 inches in d.b.h. and 26.7 feet in height. (*A*) Before pruning, 1 foot to first dead branch and 6 feet to first live branch; (*B*) 25 percent of the live crown removed, 12 feet cleared; (*C*) 50 percent, 16 feet cleared; (*D*) 75 percent, 18 feet cleared.

Conditions for growth during the 2-year period were favorable. Several months early in the 1950 growing season had less than normal rainfall but all months in the 1951 growing season had more than normal rainfall. Growth during this period has been satisfactory.

Pruning Increased Growth

In general growth increased with an increase in tree diameter and with an increase in pruning intensity through the 50 percent intensity and then decreased at the 75 percent intensity. Only d.b.h. growth of trees pruned 75 percent averaged less than that of the unpruned trees.

Diameter growth at breast height.—Growth in diameter at 4.5 feet for all trees averaged 0.45 inch (Table 2). Trees pruned 50 percent had the fastest growth and the increase over that of the unpruned trees was significant at the 5-percent level. The reduction in d.b.h. growth caused by removing 75 percent of the crown was significant at the 1-percent level. The increases in growth with increases in d.b.h. were also significant at the 1-percent level.

Diameter growth at 9 feet.—Growth in diameter at 9 feet averaged 0.54 inch and was greater on pruned trees than on unpruned trees. Here again, trees pruned 50 percent had the fastest growth and the difference between unpruned trees and trees pruned 50 percent was significant at the 1 percent level. The average diameter growth at 9 feet for the 5-inch trees was significantly greater at the 1 percent level than that of the 3- and 4-inch trees. Pruning increased the diameter growth more at 9 feet than at breast height and, in effect, reduced the taper and thus improved bole form.

Height growth.—During the 2-year period height growth averaged 3.5 feet for all trees. (Total tree height was accurately measured to the nearest one-tenth foot with a special sectional measuring pole.[2])

[2]Liming, Franklin G. A sectional pole for measuring tree heights. Jour. Forestry 44:512-514. 1946.

TABLE 1.—AVERAGE HEIGHT TO FIRST BRANCH

Amount of crown removed	D.b.h. class (inches) 3	4	5	All
		Feet		
None	2.2	1.9	2.0	2.0
Dead branches only	5.2	5.7	5.6	5.5
25 percent live crown	8.5	9.4	9.2	9.0
50 percent live crown	9.5	11.6	11.8	11.0
75 percent live crown	12.7	14.6	15.2	14.2
Total tree height	20.7	24.3	26.2	23.7

FIG. 2.—Callus growth has been rapid and many small wounds have closed after 2 years. Note that the sprout is located near and below the pruning wound.

Most pruned trees grew more in height than unpruned trees; trees pruned 75 percent had the fastest growth. The difference between check trees and those pruned 75 percent was significant at the 1 percent level.

It must be remembered that the results represent only 2 years' growth and later remeasurements will be needed to find out the full effects of pruning intensity on growth. However, it is evident that removing as much as 75 percent of the live crown did not seriously retard growth during the first 2 years after pruning.

Wounds Healed Well

Most of the pruning wounds were small and consequently very few of them exposed heartwood. Many of the smaller wounds had completely closed and most of the others will close within a year or two (Fig. 2). This indicates that

TABLE 2.—TWO-YEAR DIAMETER AND HEIGHT GROWTH[1]

Percent of crown removed	D.b.h. class (inches) 3	4	5	Mean
	4.5 FEET ABOVE GROUND (Breast height)			
		Inches		
Check	0.39	0.46	0.49	0.45
25	.42	.41	.57	.47
50	.44	.47	.53	.48
75	.33	.40	.46	.40
Mean	0.40	0.44	0.51	0.45
	9 FEET ABOVE GROUND			
		Inches		
Check	0.42	0.49	0.58	0.50
25	.49	.48	.66	.54
50	.53	.59	.68	.60
75	.46	.53	.63	.54
Mean	0.47	0.52	0.64	0.54
	TOTAL HEIGHT			
		Feet		
Check	3.03	3.23	3.40	3.22
25	3.46	3.21	3.31	3.33
50	3.37	3.58	3.97	3.64
75	3.46	3.73	3.95	3.71
Mean	3.33	3.44	3.66	3.48

[1]Data were analyzed by Analysis of Variance and differences between means subjected to the "t" test.

clear wood will be produced over the wounds within a relatively short time after pruning. Because of the rapid callus growth, the wounds will probably close before decay starts.

Sprouting Only Drawback

Sprouts, or epicormic branches, commonly occur on trees of many species after thinning or some injury or change in the crown such as that brought about by pruning. If sprouting is great on pruned trees, much of the beneficial effects of pruning will be lost.

Sprouting on the pruned trees was quite variable. The number of sprouts ranged from 0 to 13 and averaged 2.5 per sprouting tree. An average of 28 percent of all pruned trees had at least one living sprout 2 years after pruning. The percent of trees sprouting increased as intensity of pruning increased (Table 3). Only 5 percent of the trees in the 3-inch class pruned 25 percent had one or more living sprouts; whereas, 75 percent of the trees in the 5-inch class pruned 75 percent had one or more living sprouts.

The amount of sprouting was also correlated with tree side, i.e., cardinal direction, and the amount of shading from adjacent crowns. These two factors are associated with the quality and quantity of light the trees receive.

Sprouts occurred on the west side most frequently, the south side next most, and the north and east sides the least (Table 4). Each of the tree sides—north, east, south, and west—was classified as to the amount of shade received from adjacent tree crowns. The estimate of shade was based on the relative size of adjacent crowns and the distance between the observed tree and adjacent trees. Only 6.7 percent of the heavily shaded sides had one or more sprouts while 18.8 percent of those with medium shade and 28.3 percent of those with little or no shade had sprouts.

FIG. 3.—A longitudinal section of a sprout originating from a dormant bud on a 15-year-old stem. A bud trace extends from the primary wood of the sprout to the primary wood of the parent stem. The bud trace and the lateral branch (dead stub) originated at the same node.

Nearly all of the sprouts were located within 6 inches of a pruning wound, usually below the wound (Fig. 2). More than 50 sprout-bearing sections of stems were dissected to determine the origin of the sprouts. Every sprout originated from a dormant bud. A direct connection, a bud trace, was found to extend from the primary wood of the sprout through annual layers of xylem to the primary wood of the stem (Fig. 3). It is believed that most, if not all, of the sprouts originated from 1 of the 2 buds usually formed at the nodes on 1-year-old walnut stems.

Sprouting may well be the limiting factor in determining the amount of live crown that should be removed at any one time. It may be necessary to prune gradually in a series of operations or vary the pruning intensity of individual trees according to the amount of light received. In any event, plans for pruning should be included in the over-all management plan to avoid creating conditions favorable for sprouting at the time the trees are pruned. For instance, intensity of thinnings made in conjunction with pruning should be governed by the sprouting hazard.

TABLE 3.—PERCENT OF PRUNED TREES WITH AT LEAST ONE SPROUT AFTER 2 YEARS

Percent of crown removed	D.b.h. class (inches)			
	3	4	5	Mean
25	5.0	8.3	5.0	6.1
50	25.4	18.3	25.0	22.9
75	40.0	49.2	75.0	54.8
Mean	23.5	25.1	35.0	27.9

TABLE 4.—LOCATION OF SPROUTS ON TREE SIDES

Side of tree	Trees sprouting		Sprouts per side of tree
	Number	*Percent*	*Number*
North	38	7.1	1.7
East	25	4.6	1.3
South	63	11.7	1.8
West	90	16.7	2.2

Summary

Various pruning intensities were tried on trees in a 14-year-old black walnut plantation in southeastern Kansas. As much as 75 percent of the crowns of 3-, 4-, and 5-inch trees was removed.

Removing as much as 75 percent of the live crown did not result in any serious adverse effect on tree growth. Those that had 50 percent of their crowns removed were growing fastest. Pruning increased diameter growth at 9 feet more than at breast height and thus improved bole form.

All pruning wounds were healing rapidly and no decay was observed.

The occurrence of sprouts increased with increases in pruning intensities and tree size. Trees receiving the greatest amount of shade from adjacent trees had the least amount of sprouting. Sprouting may well be the limiting factor determining the amount of crown that may be removed at any one time in pruning black walnut.

Notes

The Finnish Curve Calipers

The conventional calipers, although accurate, require frequent adjustments and are rather tiresome when used on many trees. The Biltmore stick, which was designed for speed, is, on the other hand, too inaccurate for most types of work. Neither of them can be conveniently used to measure diameters of standing trees above the breast-height level.

A few years ago a new approach was presented by a forest technologist, O. E. Töyry, of the Forest Research Institute in Finland.[1] As a result, two new calipers have been designed with the purpose of combining simplicity and ease of handling with the accuracy considered sufficient for most forestry purposes. These are described below.

The Finnish curve calipers used for d.b.h. measurements have no moving parts. As shown in Figure 1*a*, the main feature of the d.b.h. calipers consists of a curved graduated arm with a handle which allows a good grip. This graduated arm is made of 7-layer plywood, 9 millimeters thick. The second arm is a fixed arm. It is made of solid wood and is set at the zero point of the graduated scale. The graduations stamped all the way across the curved arm are all parallel to the inside edge of the fixed arm. The calipers are varnished to protect them from getting soiled. The curvature of the plywood section is governed by the tangential distance from the tree to the inside edge of the curved arm. With the exception of very small diameters, the tangential distance of about 5½ centimeters was found most convenient in Finland. It is the same for all diameters and thus gives the same degree of accuracy for trees of different sizes.

When using the calipers, one grasps the handle with the left hand (the right hand is left free) and applies it against the tree with the fixed arm touching the trunk at breast height. The d.b.h. measurement or d.b.h. class can then be obtained by sighting parallel to the graduation marks, essentially as in the case of the Baltimore stick. The left arm should be stretched out as far as possible. The greater the distance between the eye and the right edge of the tree, the more accurate the measurement.

The second instrument, Figure 1*b*, is designed for measuring diameters at different heights above the breast height level. It is made precisely the same way as the first one. Its use, however, requires a pole to reach the height at which the diameter is to be measured.

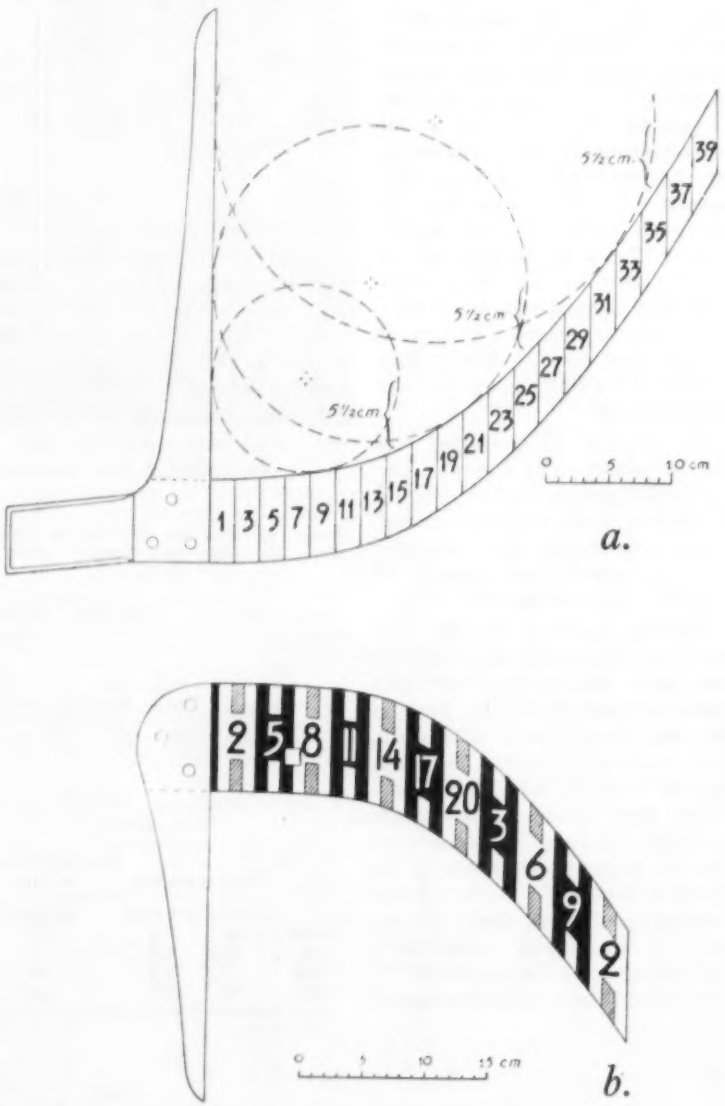

FIG. 1.—Two Finnish curve calipers. *a*. The type used for d.b.h. measurements; *b*. the type used on pole for upper diameter measurements.

[1]Ilvessalo, Yrjö. Pystypuiden Kuutioimistaulukot. (Summary in English: Volume Tables for Standing Trees.) Helsinki, Finland. 1947.

Obviously, the difficulty in reading the graduations and in handling the pole increase as one goes higher up the stem. In Finland, the diameters at 6-meter (20 feet) height, needed for the application of the Finnish volume tables, are generally measured with a satisfactory degree of accuracy. The main difficulty encountered is the poor visibility of graduations. This can be overcome by painting the successive diameter classes on the curved arm with different colors. For example, for 1-inch classes, unpainted and black strips may alternate. Narrower intervals (1 centimeter in the figure) may require the use of several colors.

A light wooden pole of suitable length can be easily made in the woods. On jobs where pole calipers are used frequently, a permanent pole made out of several sections of light metal tubing is recommended.

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Swedish Ladder Modifications for Large Trees

Miles and Hoekstra[1] described a modification of the Swedish (Wikstrom-Berg) ladder to prevent the chain's slipping out of its retaining notch. Another solution, worked out by A. R. Liddicoet, at the Institute of Forest Genetics, is to replace the retaining notch with a tire chain lock. The take-up in such a lock substitutes for the spring action, and the fastening of the chain is positively assured.

Large trees present another problem. The ladders, as delivered, have two spikes in each yoke, so located that they will engage in the bark of trees up to about 15 inches in diameter, but fail to reach the bark on larger trees. Liddicoet remedied this by moving the spikes out to the corners of the yokes, where they engage in trees of large diameters, but present a hazard in handling.

The modification shown in Figure 1 permits a non-skid engagement on trees of 4 or more feet in diameter, with some reduction in the hazard presented by a single large spike. The yoke is lined at its outer ends with strips cut from a tire retreader's buffing band or rasp. This consists of a number of short, tapering, hardened nails, similar to boot calks, driven through a strip of sheet iron. Tire retreaders discard their buffing bands when they seem quite new—at any rate usable for retreading a ladder yoke.

To attach the ladder to a 42-inch tree, a youngster in most West Coast forests, requires about 11.4 feet of chain. The 5-foot chain supplied by the manufacturer is replaced by a jack chain (See Fig. 1), which has the advantage of lighter weight (2.6 oz. per foot as compared with 3.6 oz. per foot for the chain supplied with the ladder). This chain is made of wire 0.125 inch in diameter twisted into double links 2.5 inches long. Cost is about $0.04 per foot. Since the half-links are somewhat shorter than the links of the welded chain supplied with the ladder, a finer adjustment may be secured with the jack chain.

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[1]Miles, E. E. and P. E. Hoekstra. Tree climbing safety hint. Jour. Forestry 52: 526-527. 1954.

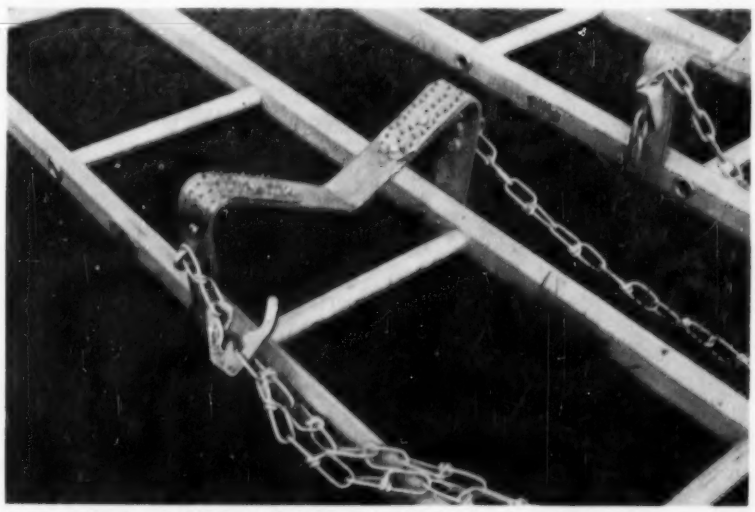

FIG. 1.—Swedish ladder modified by replacing chain retaining notch by tire-chain lock, welded chain by lighter jack chain, and single yoke spikes by multiple calk-like nails.

A New Development in Timber Sale Agreements

In most states where forestry has reached an advanced stage of development, a citizen may obtain from his forestry department a standard form of timber sale agreement. The articles of this agreement include, among other things, the purchase price, a time limit, what trees shall be harvested, what shall be done in event of disagreement between seller and purchaser, responsibility for fire prevention, and adherence to state requirements and local ordinances. Penalties are included for breach of contact and for cutting the wrong trees. On these standard forms a space is left for additional articles, or sections, which the contracting parties may wish to include.

Sometimes a forester, who has cruised or marked a valuable block of timber, and whose volume estimates for the stand have been accepted by both operator and owner, may be called upon to prepare the contract.

He will usually start with the standard form provided by the

state department. But in the space provided for additional articles of agreement he may grasp the opportunity to insert some new ideas, and to exercise a bit of imagination. His objective may be to establish better forest practices in his area. He may also have in mind the possible advantages to his clients if the timber can move to a favorable market.

During the last year the writer prepared a contract involving the harvesting of mature timber on a 50 acre woodlot. An offer of $9,000 had been made for "the merchantable portion" by operators who proposed to cut to a diameter of 14 inches on the stump. He advised that this offer be rejected; that the trees to be harvested be marked; that the selected trees be offered on a bid basis; that the forester's estimates for volume according to species be accepted by both parties.

In this contract a few paragraphs were inserted which represent, so far as the writer knows, a new development in timber sale agreements.

The operator was asked for a breakdown of the values for standing timber on which he based his successful bid of $7,400 for 470 marked trees. He offered no objection, and these figures were included in the contract. His lowest bid price per M bd. ft. appeared in the sweet and black gum column; his highest price in the white oak and tulip poplar columns.

Following consultation between forester, owner, and operator we introduced into the contract a new idea, the results of which have proved gratifying to all concerned.

First, we extended the time limit covering the period of operation—so that the operator might not be compelled to sell his product in a low market. We then agreed that the purchaser's breakdown of values per M bd. ft. should represent a minimum to be paid in any event, whether the market rose or fell. And finally we provided that the operator should increase these values in favor of the owner in event of improved marketing conditions for any or all of the species involved. In short, the operator undertook, under the terms of these special articles of agreement, and in view of the liberal time limit, to *pay the owner a dividend.*

At this point the reader will be inclined to ask how the dividends were arrived at, and whether the operator, out of the goodness of his heart, merely paid the owner a few cents or a few dollars more per M than he actually bid, and called it a square deal. The reader may also question whether such an agreement is sound from the strictly legal point of view.

The agreement called for a degree of mutual confidence and faith. But it provided for examination, by the forester, of all records of sale, careful checking of the marked trees, and comparison of the final volume harvested with the original estimates for the trees marked.

The dividend was based on the operator's normal percentage of profit. For example, if he figured to make a net profit on oak of 15 percent in today's market, but by delaying the cutting of oak for sixty days realized a profit of 30 percent, he would share the additional profit equally with the owner.

The operation above described has recently been completed, ahead of time by quite a wide margin. Fortunately the favorable market came unexpectedly and soon. The operator has paid the owner in round figures $9,500 for the trees which the forester marked, or a dividend of approximately $2,100 over the bid price named in the contract.

Bear in mind that the original offer, prior to this contract and prior to the call for bids on marked trees was $9,000. If that offer had been accepted, the timberland would have been cut to 14 inches, a diameter so low that practically nothing of value would have remained in the woodlot. Under the accepted contract the owner received $9,500 for 470 marked trees, and can look forward to harvesting another crop in approximately 15 years from the same fifty acres.

An interesting development in relation to this contract, and one which materially affected the time factor, was a sale of replacement timbers for the historic frigate Constitution (Old Ironsides). The largest and best of the mixed oak was sold by the operator to a manufacturer looking for ship timbers of extraordinary dimension for the U. S. Navy. A total of 122 M bd. ft. was required for repairs and replacements on Old Ironsides, and of this volume 42 M bd. ft. must be 14" x 16" x 32'. Only oak trees of remarkable size and soundness can furnish timbers of that dimension.

Newspapers in the area of this operation have done justice to the story of how Old Ironsides was saved again. But to a forester the greater weight of professional interest lies on the side of the timber sales agreement under which a large portion of the required material was furnished.

JAMES R. SIMMONS
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A One-Foot-Square Wire Seed Trap

Investigators studying dispersal of wind-borne tree seed may be interested in a one-foot-square wire seed trap designed at the Missoula Research Center, Missoula, Montana. Although made entirely of wire, the traps have withstood satisfactorily one winter's snow where depths reached four feet. Only two traps out of 153 set out in a 1952 seed dispersal study had to be replaced after one year's use because of snow damage, and three damaged by animals required minor repair. Their small size and light weight make the traps especially portable as well as easy to empty for examining contents.

Twenty-one seed traps placed in uncut timber furnished the following estimate of the western larch (*Larix occidentalis* Nutt.) 1952 bumper seed crop: mean 5.71 seeds per trap, standard deviation 3.43, standard error 0.75, and fiducial limits at the 5-percent level 4.15-7.27. Seventeen one-quarter-mil-

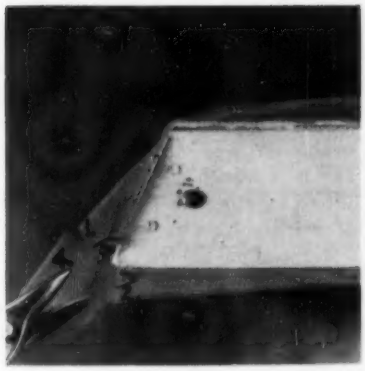

FIG. 1A.—1. Cut through fold to pattern point at about 70° angle (all corners).
2. Cut to pattern point at about 70° angle (all corners).
3. Fold *1*, *2* and *4*, in that order, flat against side of pattern and crease.
4. Trim away excess.
5. Remove from pattern and staple corners and edges with paper stapler.

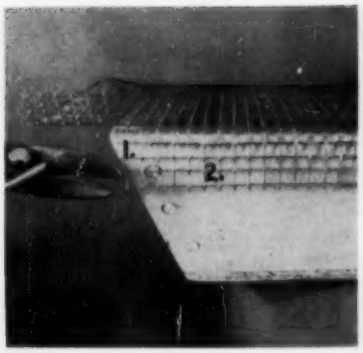

FIG. 1B.—1. Cut to pattern point at right angles to the side (all corners).
2. Fold down at right angles to top.
3. Fold down at right angles to top and bend flap around corner and tie with wire.
4. Remove from pattern and attach top to basket as illustrated below.

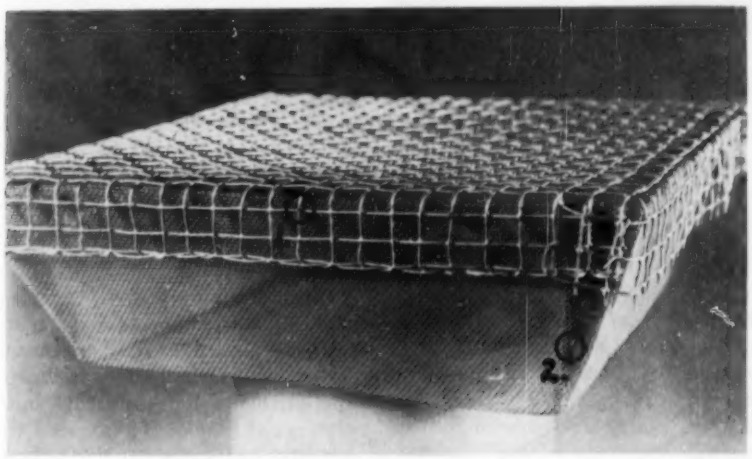

FIG. 1C.—A completed seed trap illustrating (1) top wired to side, and (2) stapled corner.

acre seed traps gave a nearly identical estimate of seeds per acre in the same period and general area. The coefficient of variation of the large trap estimates was 43.3 percent as compared with 60.1 percent for the small traps. Although the estimate from the 17 larger traps had less variation, their cost was three times greater than the 21 smaller traps.

Each small trap was placed on a leveled spot of ground in a trap-size depression dug with a pulaski tool. The top of each trap extended about one inch above the ground surface. Traps were transported completely assembled because the study areas were easily accessible. However, they may be transported easily for greater distances by nesting the tops and baskets separately and tying them together on arrival at the study site.

The cost per trap was as follows:

Item	Amount	Cost
Labor	0.96 hr.	$1.50
Window screen	20 in. sq.	0.19
Hardware cloth	15 in. sq.	0.14
Fine wire, staples	Small	0.01
		$1.84

Construction methods and a finished trap are illustrated in Figure 1. Folding, cutting, and creasing of the wire material should be done on the wooden pattern, of which the outside dimensions are: top, 12 inches square; bottom, 9 inches square; and depth, 4 inches. The 20-inch square of window screen should be centered over the inverted pattern and tacked at the four corners and two places on each side to form the basket. Sides of the wire material are placed parallel to respective sides of the pattern. The 15-inch square of hardware cloth may be held in place by hand. Succeeding steps are illustrated in Figure 1.

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Junior Aerial Photos for Fire Control

Small scale stereograms copied from existing aerial photographs have been made and successfully used in fire suppression and fire control planning to supplement maps, primarily for fast and economical location of control lines and cover types, and for similar intelligence. These photos are used for the same purposes and generally in the same way as are stereoscopic pairs of conventional 9- x 9-inch vertical aerial photos; the essential difference being that size and clarity of detail have been traded for several conveniences important in fire fighting.

The chief benefit of these small stereograms is their greater adaptability to field use by suppression personnel. This advantage over conventional aerial photos results from these characteristics:

1. Ease of use by men having a minimum of training in use of aerial photos.
2. Speed and convenience of use under fireline conditions.
3. Low cost per print.
4. Compact to carry.
5. Can be reproduced rapidly.
6. Point designation grid on every print.

A junior photo, full scale as used, is shown in Figure 1.

Preparation of Small Scale Stereograms

Junior photos are stereograms at a scale of 1:50,800 made by copying 9- x 9-inch contact prints. The original photos are double weight, "semi-matte," at scale of 1:20,000,

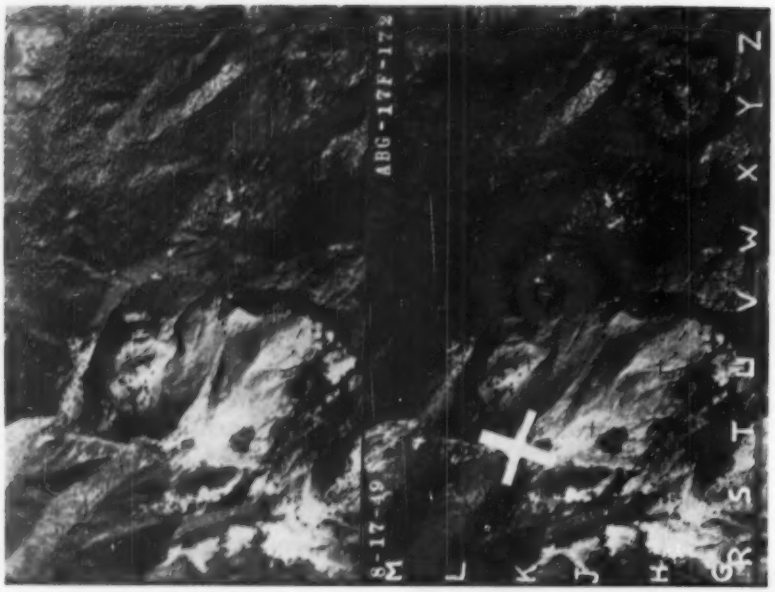

FIG. 1.—"Junior photo" 1:50,800 stereogram, full scale.

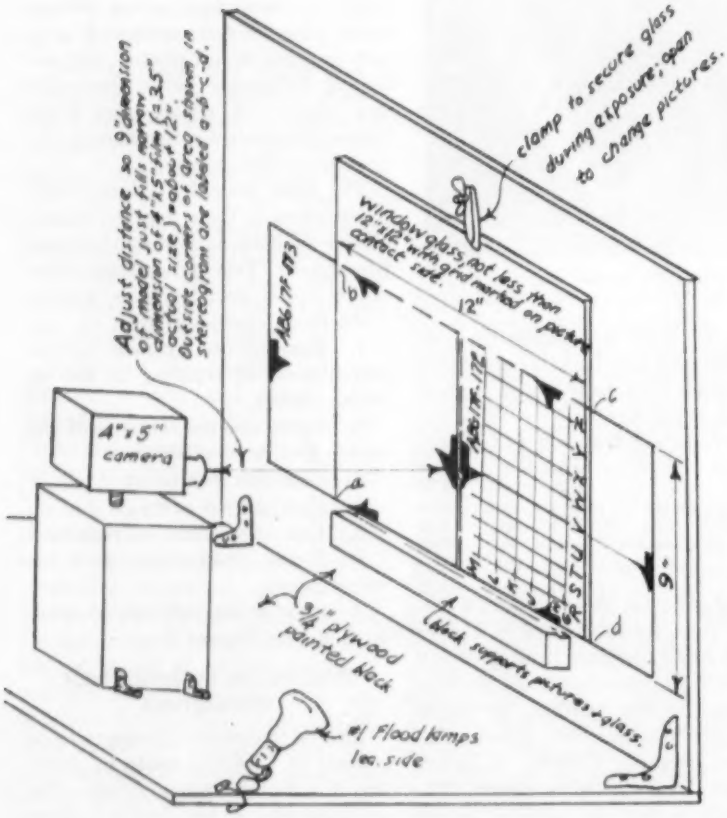
clamp to secure glass during exposure; open to change pictures.
Adjust distance so 9" dimension of model just fills narrow dimension of 4"x5" film (3.25" actual size) - about 12" outside corners of area shown in stereogram are ideal 9"x9".
4"x5" camera
window glass, not less than 12"x12" with grid marked on contact side.
12"
ABC-17F-172
9"
3/4" plywood painted black
(block supports pictures + glass.
#1 Flood lamps
toc. side

FIG. 2.—Jig setup for making stereograms.

are obtainable from the U. S. Forest Service and the Commodity Stabilization Service (formerly PMA). Any standard photo copying method may be used. A serviceable setup is shown in Figure 2. The 9- x 9-inch contact prints are butted together (without alignment of principal points), thus making a stereoscopic model. A 4- x 5-inch camera is set at a distance such that the narrow width of the film is just filled by the 9-inch dimension of the contact print. Thus a picture is produced showing the full width of each original and 6 inches each side of the butt joint. A 4- x 5-inch Speed Graphic or similar camera with Kodak Panatomic-X or Kodak Commercial film does well for this step. The final 4- x 5-inch print can be made on any *fine grained* photographic paper, such as Kodak AZO, which will take markings of pencil, pen, and grease pencil. One sheet of single strength window glass is used to hold the 9- x 9-inch picture flat during exposure; the south half of the glass is gridded on the picture contact side at intervals of one inch.

Butting pictures without alignment is satisfactory. Experimenting and sampling indicate that, costs being considered, the best production method is simply to butt pictures at time of copying and reject any badly aligned prints produced. No models were found to be so badly aligned as to prevent good stereoscopic vision. Six inches of each 9- x 9-inch picture in original model gives sufficient overlap to be satisfactory for purposes of continuity between stereograms. A scale of 1:50,800 is good for spacing for both lens and bare-eyed stereoscopic vision. Detail is limited by grain of film on which the stereogram is printed. Visual scale of junior models under a lens stereoscope is about the same as 9 x 9 photos under a mirror stereoscope, but detail is less clear with junior models owing to grain of print.

A one-inch grid is used on the original which is one centimeter on the junior models at 1:50,800; i.e., on junior models made from 1:20,000 original contact prints one cen-

timeter equals 1,666 feet. The grid is oriented to make the *H* and *V* lines coincide with fiducial marks. Thus, any picture point will have the same grid coordinates regardless of scale of reproduction or whether reproduced as model or single. The grid may be extended to cover completely any 9- x 9-inch picture. The letters of the grid have been chosen for radio sound and alphabetical order except for omitting *I* (Fig. 3). The grid is read, "Right-Up," distances between letters being estimated to tenths. To illustrate, the hilltop marked "X" in Figure 1 and in Figure 3 is designated "Photo 17F-172, S7K2." A graphic scale (1.25 inch to 1 mile) may be added, preferably by rubber stamp, on edge of back of each print. Addition of a scale to the grid template is not desirable owing to the obscurity of detail which would result, the area of which detail is limited by the film size of the 4- x 5-inch camera.

Costs for small quantity production is approximately 15c per model to produce negatives (for material cost only; or 75c per model for negatives by commercial photographer) and 10c per print.

Thus, cost of negative and three prints is about 25c per square mile (@ 1.8 square miles per model).

Field Use

Equipment for field use need be only the standard pocket stereoscope. A convenient addition for use in vehicle, plane, or during short walks is a Masonite board ⅛ x 4 x 8½ inches to which photo and stereoscope are secured with binder clips when in use. A man driving a pickup, after the stereoscope and stereogram are clipped to the board, may repeatedly set the stereoscope and board aside and pick them up for re-use with no further orientation or adjustment, as is required with 9- x 9-inch pictures. It is practical, when in frequent use, for a man to suspend the stereoscope and photo from his neck, only one hand being required when viewing. Stereoscope, board, and pictures will fit into a shirt pocket when folded. Bare-eyed stereo is easy for some individuals and shows good detail for fire suppression use.

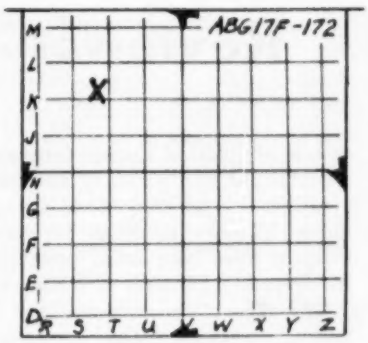

FIG. 3.—Photo grid on 9 x 9 inch aerial photo. *X* is at S7K2. Grid lines spaced at 1 inch; *V* and *H* lines centered on fiducial marks.

Experience on two large fires and some truck trail planning leads to several conclusions regarding application of junior photos:

1. Effectiveness in saving fire control time and money is great owing to potentially faster decisions by fire boss and better line location with minimum of foot, plane, or helicopter scouting.

2. Efficient cataloging and indexing are important. A good system is comprised of topographic quadrangles, packages of photos by quads, dittoed sheet for each quad listing one picture point for each photo. This list shows grid designation, common name, as "mouth of Clear Cr." or "Hill 2712," and mile coordinates from west and south neatline of quad. This system permits rapid expansion with no office work except sorting prints if many prints are suddenly needed in one area during a campaign fire. A centerspot index on planimetric map has been found unsatisfactory and is insufficiently precise.

3. Effectiveness of use is in proportion to preparation in regard to: (a) training in map and photo reading, and (b) photo cataloging and indexing.

4. Photo coverage should be complete in any area bounded by some marked feature, as a county road or river, so that field men can quickly learn what areas are covered. For both economy and compactness, however, coverage should be confined to areas of difficult cover and terrain.

5. It is desirable to make a prefire arrangement with a local photographer for rapid printing of additional copies of photos that may be suddenly required for campaign fire suppression.

6. It is good fire control business to have every leader or scout, who is likely to locate fire lines or move men on his own initiative in heavy cover or rough terrain in possession of, *and trained to use*, the photos in his assigned area of the fire.

Conclusions

General use of this application of aerial photos offers these benefits:

1. Less supervisory effort in designating the location of work to be done and increased speed and reliability of this effort.

2. Greater initiative by fire line leaders because of their possession of better information as to cover and terrain.

3. Greater control of fire line leaders by fire boss, owing to increased precision with which he may designate jobs.

Our brief experience indicates that junior photos are likely to find widespread application by fire control agencies. It is very desirable to have all agencies adopt an identical system so far as possible. In the interest of early and final standardization, we hope that other fire control agencies will test this application of aerial photos to their organization, and will forward ideas for improvements and changes indicated by their experience.

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[1]Credit is due Robert Colwell, University of California, for recommendations that grid be copied onto negative and that copying be done in models, both features having since been shown to be of great value in fighting fire.

Reviews

Rehabilitation and Development of Agriculture, Forestry and Fisheries in South Korea

414 pp. Columbia University Press, New York 27, N. Y. 1954. $8.50.

This monumental work was compiled by the highly competent staff of the F.A.O. mission to Korea which consisted of eleven men. Mark B. Williamson, U. S., was chief of mission. Sir Herbert Howard, U. K., was the forestry specialist. The mission was under contract with the United Nations Korean Reconstruction Agency to investigate conditions and to prepare a report with recommendations for use in the reconstruction programs in the Republic. The work was begun in August 1952 and completed early in 1953.

The book is divided into four parts. The first contains the introduction and summary, including general recommendations. The second contains 271 pages devoted to agriculture. The third contains 53 pages devoted to forestry. The last section contains 35 pages concerned with fisheries. The major emphasis is on agriculture, which is unfortunate for the ROK has about 73 percent of its area in nonagricultural, or forest, land; and the forest resources are in great need of reconstruction.

The recommendations are realistic, for the most part, and show the high caliber of the men who collaborated in this work. The study of forestry resulted in 31 recommendations, most of which are of a nature to be carried out by the ROK government rather than by any reconstruction agency.

Several of those suitable for action by an outside agency, such as the reconstruction of the Central Forest Experiment Station, the aid to forestry education through the Department of Forestry of Seoul National University, technical assistance and material aid to forest administration through the ROK Bureau of Forestry, the sending abroad of qualified Korean forestry students for further study and the arrangement for short term study abroad of older practicing forestry officials, have been acted upon by the Forestry Division of UNKRA.

The report was prepared for a specific purpose, that of background and guidance for the action program in reconstruction. Of all the reports of all the many missions which descended upon Korea in recent years this is undoubtedly the most thorough and competent job.

J. Hugo Kraemer

Photographic Measurements: Problems and Solutions

By Gomer T. McNeil. 244 pp. Illus. Pitman Publishing Corporation, New York 36, New York. 1954. $5.

The primary aim of this book, as stated by the author, is "to make available, for ready reference, 101 basic problems and solutions involving the general application of measurements in photography."

In view of the large number of books on photogrammetry that have preceded this one, it might well be asked whether a book such as this, dealing only with basic photogrammetric relationships was really needed. In this reviewer's opinion such a book has been needed for a long time. "Photographic Measurements" is not merely a recompilation of photogrammetric relationships derived during the century —and more—that man has been taking pictures. It is an original and remarkably successful attempt to provide the working photogrammetrist or photo interpreter with a mathematical reference manual that he will find both understandable and pertinent to his work.

The value of this book can easily be underestimated by the casual reader. Its usefulness to a forest photogrammetrist will increase as he becomes more familiar with its contents and organization.

The comprehensiveness of the book is indicated by the fact that it surveys the field of photogrammetry, broadly defined, from shutter calibration to stereoscopy, from lens optics to relief enhancement, and from image motion compensation to high altitude stereo techniques.

Like all books, this one has certain limitations. To illustrate some of these limitations let us suppose that the forester's specific problem takes the form of this frequently asked question: "How much does the relief appear to be exaggerated in this stereoscopic model when I view it through my lens stereoscope?"

Whether he resorts to the book's index its abbreviated table of contents, its detailed table of contents, or to a mere "leafing-through" process he may have trouble finding the answer to this question. His attention may first be directed to Problem 24 where there is, indeed, an excellent treatment of stereoscopic vision. But since this does not enable him to answer his specific question he may next turn to Problem 37 which shows him clearly how to calculate the "relief enhancement" factor. However, this term is not defined, except mathematically, so he may well wonder what a relief enhancement factor of "30,000" means with reference to his question. Finally in Problem 38, he finds a sample calculation of the "relief stretching" factor. But unfortunately there is no direct provision here for the optics of his stereoscope. Should he become impatient at this point, he would do well to remind himself that this book professes to treat only 101 problems, and that his particular problem, though a common one, apparently falls in the "200" series. Here we see the value, as previously mentioned, of thoroughly familiarizing one's self with the book. Had our frustrated forest photogrammetrist found time to do this previously, he might now

recall that, elsewhere in the book, in a problem dealing with lens optics there is an example which, in conjunction with Problem 38, enables him to answer his specific question.

It will undoubtedly strike many readers as peculiar that not a single photograph is shown in this entire book on "Photographic Measurements." The only factor which prevents this from being a serious limitation is the excellent series of illustrations drawn by Mr. Christopher Mares.

In summary, this book should be a welcome addition to the library of any forest photogrammetrist, because of its great potential value to him as a reference manual. But until he thoroughly familiarizes himself with its contents and organization, the book may lie there on the shelf with its pages unblemished by the pencilled notations and dog-eared corners that are a true measure of its usefulness.

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University of California

Forestry Dictionary: Swedish—English—German—French

By M. E. Simonen. 284 pp. Swedish Forestry Association, Regeringsgaten 18, Stockholm C, Sweden. 1954. 35 Crowns (approximately $6.80).

This flexible leather bound dictionary includes 2616 words. It is so arranged that the terms in all four languages appear in a line across the page, alphabetically, based on the Swedish terms. However, there are alphabetical indexes in English, French, and German.

The dictionary is not confined to purely technical terms in forestry and forest products. It includes also the more common words with specialized meaning that may be found in forestry literature.

There is no other single dictionary covering these four languages and none that is as complete. Those having occasion to read or translate technical forestry and forest products terms will find this book helpful.

PAUL A. HERBERT
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Bark Structure of North American Conifers

By Ying-Pe Chang. 86 pp. Illus. U. S. Dept. Agric. Tech Bul. 1095. Supt. of Documents, Washington 25, D. C. 1954. 35 cents.

There is a dearth of information on the anatomical structure of tree barks. One becomes acutely aware of this lack of knowledge if he is concerned with bark utilization. Dr. Chang and the Forest Products Laboratory are to be commended for this effort to remedy the situation with respect to the North American conifers.

The stated objectives of this research are to determine the basic anatomical structure of coniferous bark, to evaluate the bark features of diagnostic value and other related findings as means for bark identification, and to induce the viewpoints that would correlate bark structure to closely related research.

Descriptions of bark structure given in this bulletin are confined to their generic characteristics and the differences among species within a genus. Thereby, repetition of all the similarities of closely allied species is reduced as much as possible.

The species selected for study are those of commercial importance for timber or of other special economic value and those whose anatomical characteristics should be learned in order to establish reliable criteria for recognizing their bark by structure. Fifty-seven species in 15 genera were examined by means of permanent or temporary slides. The species reported in some detail are Pacific yew, California torreya, grand fir, tamarack, white spruce, western white pine, shortleaf pine, Douglas-fir, western hemlock, redwood, bald-cypress, Atlantic white-cedar, Port-Orford-cedar, Monterey cypress, eastern redcedar, incense-cedar, and northern white-cedar. Other species are compared with these and important structures and patterns of cell arrangement are illustrated by photomicrographs.

This publication certainly belongs in the library of every wood anatomist and should be of interest to all concerned with bark utilization. It is a worthwhile contribution to the literature of plant anatomy.

IRVING H. ISENBERG
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Questions of Forest Sciences

The Publishing House of the Academy of Sciences of the USSR, Moscow. 415 pp. 1954.

Each delegate to the Fourth World Forestry Congress held at Dehra Dun, India, December 11 to 22, 1954, was presented by the Russian delegation with a copy of the book *Questions of Forest Sciences*.

The book contains 17 technical articles on forestry each published in Russian followed by an English translation. A different author is responsible for each subject discussed. Some are little more than general treatments of a subject, others involve the presentation of research results. It probably gives a good cross section of current research and forest practice in Russia.

The first chapter presents new information on the forest resources of Russia, based on data collected January 1, 1953. Apparently this is the first foreign release of this information. The total forest area in Russia reported in a recent FAO release is 743 million hectares; that in *Question of Forest Sciences* is 1,068 million hectares. Information is given also on the distribution of species and the percentage of the forests in various age classes. The forests are classified as belonging to three groups:

1. Forests for protection and esthetics in which only light cutting on the selection system is allowed;

2. Forested areas in the central steppe region where cutting is limited to the annual growth; and

3. Timber producing forests in which all systems of cutting are allowed with restocking left to local government.

In Chapter 2 Professor Sukachev presented his system of type classification. His system is based on the concept of biogeocenosis. Biogeocenosis is defined as "any plot of

the surface of the globe where for some space biocenosis and the parts of the atmosphere, lithosphere, hydrosphere and pedosphere that correspond to it remain the same and react on one another in a uniform way, thus forming in the aggregate an indivisible interdependent complex. Biocenosis is made up of phytocenose (plant community) and zoocenose (animal community) which react on one another."

A third chapter deals with the application of the Sukachev concept to forest management in the USSR. If the application involves only what is given in the article it scarcely lives up to the concept proposed by Sukachev.

A chapter on forest hydrology presents experimental material for forest types on the moisture lost through transpiration, evaporation from the ground cover, and interception by the crown, and how these vary with age of the stand.

The chapter on soil presents ash analyses of leaves of oak and pine growing on the dark grey soils as opposed to the sandy and podzol soils. The difference in ash composition is striking. This chapter contains special information on the water regime in forest soils and the effect of shelterbelts on the moisture available for crops.

Russian foresters appear to have full confidence in the future use of wood as they find that despite the recent introduction of metal, wood is being used to an increasing extent each year for construction. They also are cognizant of the need for silvicultural measures that will produce wood of high strength quality.

Effort in the vast area of northern commercial forests is concentrated primarily on cheap logging and on transport of logs and timber. The wood research laboratory of the Academy of Sciences in Russia has been studying machining, finishing, drying by high temperature and by liquids, bending, preserving, compressing, stabilizing, and gluing of wood.

Other chapters deal with afforestation, reforestation, erosion control, silviculture in mountain forests, oak management, wood hydrolosis, and naval stores.

General distribution of the book is still to be made.

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College of Forestry

Woody Plants for Landscape Use in the Northeastern United States

By L. J. Enright. 127 pp. College Science Publishers. State College, Pa. 1955. $3.

Woody Plants for Landscape Use will prove helpful to landscape architects, nurserymen, and home builders who want to select the right tree or shrub to fit the right place but do not possess the technical knowledge to make the proper choice. It anticipates the consumers' demands from a landscape point of view.

The book is made up of a series of lists covering six hundred trees, shrubs, and vines suitable to the climate of the northeastern United States. These lists appear under three general sections.

In Section I, the plants are divided according to their size and whether they are evergreen or deciduous.

In Section II, the plants are listed according to those basic characteristics which are helpful in landscape design. Such characteristics cover color of the bark, color and structure of the twigs, leaves, flowers and fruit. The environmental and habitat factors, such as shade, soil, moisture, and resistance to insects and disease, also form a basis for further classification.

In Section III, the plants are listed according to their intended use, such as those especially suitable for lawns, those adapted to street planting and those suitable for hedges, screens, mass and woodland planting, and those useful for wildlife.

The only criticism that I have with this book is that a few of the trees, such as the ailanthus, box elder, Carya (hickory), and *Acer saccharinum* (silver maple) are species that I would not recommend. The ailanthus is short-lived and brittle; the box elder is a poor, uninteresting, and short-lived species; the hickory is hard to transplant and few, if any, of the nurseries carry it; the silver maple is short-lived and brittle, and its roots undermine sidewalks and clog underground sewer and water pipes.

The reader who has had a long experience will overlook the few undesirable species and find the rest very helpful.

J. J. LEVISON
Sea Cliff, L. I., N. Y.

Publications of Interest

Forest Hygiene in Great Britain by W. R. Day is Forestry Bulletin No. 4 of the University of Toronto. The subject of forest hygiene as discussed has to do mainly with the forests that are being established under Great Britain's afforestation program, and the bulletin should be of interest to American foresters concerned with planting. Available from the University of Toronto Press; $1.

* * *

Personalities of the Woods is a collection of 48 personality sketches written by Stewart Holbrook about leading figures in the western logging industry. The sketches began as part of a series of advertisements of the Bethlehem Pacific Coast Steel Corporation and are here brought together in booklet form. Interesting reading about colorful figures in a colorful industry.

Current Literature

Compiled by MARTHA MEELIG, *Librarian, State University of New York College of Forestry*

Range Management Section Compiled by FRANCES FLICK, *Library, U. S. Department of Agriculture*

General

Forests of France. By J. L. Reed. 296 pp. Illus. Faber & Faber, London. 21s.

Questions of Forest Sciences. The Academy of Sciences of the USSR Institute of Forests, Moscow. 1954. 426 pp. In English and Russian.

Forest Products

Statistical Record of the Lumber Industry in British Columbia. By J. T. B. Kingston. Part II, Sects. 2 & 3. Bur. of Economics and Statistics, Victoria, B. C. rev. 1955. Mimeog.

Forest Resources

Forest Resources and Industries Wayne County, Tennessee. By W. H. Ogden. 74 pp. Illus. TVA, Norris. 1954. Rept. No. 213-54. Mimeog.

Forest Statistics for Deschutes Co., Oregon. By F. L. Moravets. 24 pp. Pacific Northwest Forest and Range Expt. Sta., Portland, Ore. 1954. Forest Survey Rept. No. 116. Mimeog.

Forest Statistics for Harney Co., Oregon. By F. L. Moravets. 23 pp. Pacific Northwest Forest and Range Expt. Sta., Portland, Ore. 1954. Forest Survey Rept. No. 118. Mimeog.

Forest Statistics for Kittitas Co., Washington. By F. L. Moravets. 24 pp. Pacific Northwest Forest and Range Expt. Sta., Portland, Ore. 1954. Forest Survey Rept. No. 117. Mimeog.

Logging and Lumbering

Die Ernte des Holzes (Harvesting of Wood). By H. Gläser. 150 pp. Illus. Wirtschafts-und Forstverlag Euting KG. Neuwied/Rhein. 1954. D.M. 6. 90.

Protection

Forest-Fire Control in the Lake States. By J. A. Mitchell. 11 pp. Lake States Forest Expt. Sta., St. Paul, Minn. 1954. Misc. Rept. No. 32. Mimeog.

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Maximum Moisture Content Method for Determining Specific Gravity of Small Wood Samples. By Dinna Smith. 8 pp. U. S. Forest Products Lab., Madison, Wis. 1954. Rept. No. 2044. Mimeog.

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Properties of American Beech in Tension and Compression Perpendicular to the Grain and Their Relation to Drying. By E. L. Ellwood. 82 pp. Illus. Yale School of Forestry, New Haven, Conn. 1954. Bul. No. 61. $1.50.

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Wood Anatomy of the Aceraceae Indigenous to the United States. By E. W. Stark. 26 pp. Illus. Purdue Univ. Agric. Expt. Sta., Lafayette, Ind. 1954. Station Bul. No. 606.

Society Affairs

Officers and Council
1954-1955

E. L. Demmon, *President*
Southeastern Forest Experiment Station
Federal Building
Asheville, N. C.

William J. Brown
Woodlands Department
Kimberly-Clark Corporation
Neenah, Wis.

C. Huxley Coulter
Florida Forest Service
Tallahassee, Fla.

D. B. Demeritt
Dead River Company
6 State Street
Bangor, Me.

DeWitt Nelson, *Vice President*
Department of Natural Resources
State Building 1
Sacramento, Calif.

Stanley G. Fontanna
School of Natural Resources
University of Michigan
Ann Arbor, Mich.

Percy D. Hanson
U. S. Forest Service
Federal Building
Missoula, Mont.

Edwin F. Heacox
Weyerhaeuser Timber Company
Tacoma 1, Wash.

Henry Clepper, *Executive Secretary*
Mills Building, 17th Street at Pennsylvania Avenue, N. W.
Washington 6, D. C.

Joseph S. Illick
State University of New York
College of Forestry
Syracuse 10, N. Y.

J. Herbert Stone
U. S. Forest Service
729 N.E. Oregon St.
Portland 8, Ore.

Ruthford H. Westveld
Department of Forestry
University of Missouri
Columbia, Mo.

School Box Score
1955 Membership

School	Student applications received: May 1955	Eligibles[1] 1955	Total 1955
Alabama Polytechnic Institute	0	27	18
University of California	1	46	16
Colorado A & M College	1	63	4
Duke University	0	11	2
University of Florida	2	22	6
University of Georgia	0	65	20
University of Idaho	1	31	3
Iowa State College	2	65	12
Louisiana Polytechnic Institute	9	19	12
Louisiana State University	11	41	25
University of Maine	2	56	15
University of Massachusetts	0	38	8
Michigan State College	2	60	35
University of Michigan	3	46	17
University of Minnesota	3	40	10
University of Missouri	1	32	9
Montana State University	1	98	18
State University of New York	2	99	22
North Carolina State College	0	59	20
Oregon State College	0	81	9
Pennsylvania State University	2	104	35
Purdue University	0	51	24
Utah State Agricultural College	0	28	7
University of Washington	3	88	30
West Virginia University	1	29	7
Yale University	1	29	17
Totals	48	1,328	401

[1]Includes Juniors and Seniors who will be eligible for Junior Membership upon graduation and Graduate students in approved curricula who are not yet eligible for Junior Membership.

Section Box Score
1955 Membership

Section	Applications received[1]: May 1955	Total 1954	Total 1955
Allegheny	5	68	46
Appalachian	1	48	28
Central Rocky Mountain	1	26	5
Central States	1	80	69
Columbia River	9	56	42
Gulf States	24	57	67
Inland Empire	1	39	4
Intermountain	1	14	10
Kentucky-Tennessee	0	5	3
New England	3	54	45
New York	5	40	31
Northern California	1	34	25
Northern Rocky Mountain	7	35	32
Ozark	2	49	20
Puget Sound	10	61	46
Southeastern	4	128	56
Southern California	0	2	3
Southwestern	3	7	8
Upper-Mississippi Valley	8	64	29
Washington	1	7	3
Wisconsin-Michigan	5	11	16
Totals	92	885	588

[1]Student, Junior, Affiliate, Associate (Initial) grades only.

The President's Column

E. L. DEMMON

During the last several months I have inquired from various Society members around the country the reasons why so many qualified men are not presently members and why members drop out every year by resignation or for nonpayment of dues. In general, I believe it is because we have not made the Society, including its local Chapters and Sections, sufficiently attractive to these men. We must have failed to impress upon them that Society membership is a professional obligation.

The JOURNAL OF FORESTRY, one of the foremost technical forestry periodicals in the world, reaches all members monthly and for some men this is their principal contact with the Society. Several have told me that the JOURNAL is too technical and is of little interest to them, but no member should appraise the value of his Society membership solely on the basis of the JOURNAL. No matter how much time and effort go into this excellent publication, members need more stimulus from their profession than receiving the JOURNAL monthly.

Each Society member should feel that he is an integral part of his professional group. But to get the most from his membership he should also be willing to contribute something to the Society. Society officers at the national, regional, and local level should arrange that every member be invited to participate in one way or another in the organization. This can be done through attending and taking an active part in local programs or in committee work, or otherwise. Only a relatively small proportion of the membership can attend national meetings; even getting to local meetings offers difficulties. There are still many geographical areas where local Chapter organizations could be set up.

I suggest that all members in a supervisory capacity urge their men to attend Society meetings, and allow them time to do so even though it is not possible to pay expenses. Also, they might well advise nonmembers, particularly young men, of the place of the professional Society in a forester's career, the opportunities it affords, and the chance it gives to foresters to meet their professional responsibilities. I have attended many national and Section meetings of the Society entirely at my own expense. Certainly, these gatherings offer opportunities for professional improvement and to exchange views on technical forestry subjects with men working in various fields of forestry and for different organizations.

It is also the responsibility of local and national officers to arrange interesting and stimulating technical programs so that these affairs do not develop into merely social gatherings. It has also been intimated that Society members are sometimes clannish or inclined to be snobbish. Although I have not noticed any such tendency, I do feel that every Section and Chapter should have a welcoming committee whose function would be to see that the younger foresters and visitors are introduced around and made to feel at home at every Society gathering.

What are some of the reasons expressed as to why so many qualified foresters are not members of the Society? Many reasons are given, some valid, some merely excuses. Quite a few men claim that they have not been invited to join. This suggests that Society membership committees are not functioning adequately. I urge every member to make it a point to find out how many of his associates qualified for some grade of Society membership are not now members, and invite them to join. Some may have considered it immodest to seek membership on their own initiative. Others who were formerly members may hesitate to ask for reinstatement. These men will be gladly taken back and any unpaid back dues forgiven, for this year only, until December 31, 1955. Let's see that every one of these men is asked to rejoin.

Another excuse for nonmembership is the cost. This may be a valid reason in some cases, particularly for young men with families who are just getting a start in their professional career. To these men even $6 per year is quite an item. However, this barely covers the cost of the JOURNAL. For an explanation of Society income and expenses, please refer to my column in the May 1954 issue of the JOURNAL.

Certainly we do not wish to put pressure on anyone to join the Society nor should we discriminate in any way against nonmembers. We should not hesitate, however, to point out the advantages of membership in this, the only professional forestry organization in the United States, and the largest group of its kind in the world.

Many of the younger foresters may not yet have reached the stage of maturity where they fully appreciate the importance of being a member of a professional organization and participating in professional society activities. Student membership, however, has helped to minimize this excuse.

Most of what one gets out of an organization is dependent on what he is willing to put into it. Let the older members make sure that younger members are given every opportunity to participate in one or another form of Society activity. Let us all as professional men maintain high professional standards according to our Code of Ethics and make nonmembers feel they are missing something by not being members of the organization representing the profession at which they earn their living. And if any member has ideas on how to improve the Society, please communicate with your President.

Membership in the Society of American Foresters is open to every qualified forester in the United States and Canada. Such membership is one recognition of a man's professional abilities. I urge every qualified nonmember to join the Society and take an active part in its many activities. This should not only lead to his professional improvement, but will help advance the profession of forestry.

E. L. Demmon

Coming Events

Allegheny Section Summer Meeting

The summer meeting of the Allegheny Section has been set for August 5 and 6 at the Fernow Experimental Forest, Elkins, W. Va.

Gulf States Section

The annual meeting of the Gulf States Section will be held at the Buena Vista Hotel, Biloxi, Miss., May 26 and 27.

Colleges and Universities in the United States Offering Instruction in Forestry

APRIL 1, 1955

Accredited

The following institutions are accredited for forestry instruction by the Council of the Society of American Foresters.

Alabama Polytechnic Institute, Department of Forestry, Auburn, Ala.

University of California, School of Forestry, Berkeley 4, Calif.

Colorado A. & M College, School of Forestry and Range Management, Fort Collins, Colo.

Duke University, School of Forestry, Durham, N. C.

University of Florida, School of Forestry, Gainesville, Fla.

University of Georgia, School of Forestry, Athens, Ga.

University of Idaho, College of Forestry, Moscow, Idaho.

Iowa State College, Department of Forestry, Ames, Iowa.

Louisiana Polytechnic Institute, Department of Forestry, Ruston, La.

Louisiana State University, School of Forestry, Baton Rouge 3, La.

University of Maine, Department of Forestry, Orono, Maine.

University of Massachusetts, Department of Forestry and Wildlife Management, Amherst, Mass.

Michigan State College, Division of Conservation, East Lansing, Mich.

University of Michigan, School of Natural Resources, Ann Arbor, Mich.

University of Minnesota, School of Forestry, St. Paul 1, Minn.

University of Missouri, Department of Forestry, Columbia, Mo.

Montana State University, School of Forestry, Missoula, Mont.

State University of New York, College of Forestry, Syracuse 10, N. Y.

North Carolina State College, School of Forestry, Raleigh, N. C.

Oregon State College, School of Forestry, Corvallis, Oreg.

Pennsylvania State University, School of Forestry, State College, Pa.

Purdue University, Department of Forestry, Lafayette, Ind.

Utah State Agricultural College, School of Forestry, Range and Wildlife Management, Logan, Utah.

University of Washington, College of Forestry, Seattle 5, Wash.

West Virginia University, Division of Forestry, Morgantown, W. Va.

Yale University, School of Forestry, New Haven 11, Conn.

Not Accredited

The following institutions offer professional and technical curricula in forestry, but do not meet the requirements for accreditation.

Arkansas Agricultural and Mechanical College, Department of Forestry, College Heights, Ark.

Stephen F. Austin State College, Department of Forestry, Nacogdoches, Tex.

University of Connecticut, Department of Forestry and Wildlife Management, Storrs, Conn.

Harvard University, Harvard Forest, Petersham, Mass.

Michigan College of Mining and Technology, Department of Forestry, Houghton, Mich.

Mississippi State College, Department of Forestry, State College, Miss.

University of New Hampshire, Department of Forestry, Durham, N. H.

Oklahoma Agricultural and Mechanical College, Department of Forestry, Stillwater, Okla.

University of the South, Forestry Department, Sewanee, Tenn.

Virginia Polytechnic Institute, Department of Biology, Blacksburg, Va.

State College of Washington, Department of Forestry and Range Management, Pullman, Wash.

Introductory, Preforestry, and Specialized Courses

University of Arkansas, Department of Horticulture, Fayetteville, Ark.

Centenary College of Louisiana, Department of Biology, Shreveport, La.

Clemson Agricultural College, School of Agriculture, Clemson, S. C.

Cornell University, Department of Conservation, Ithaca, N. Y.

Grand Rapids Junior College, Grand Rapids, Mich.

Humboldt State College, Forestry Department, Arcata, Calif.

Idaho State College, Pocatello, Idaho.

University of Illinois, Department of Forestry, Urbana, Ill.

University of Kentucky, Department of Horticulture, Lexington, Ky.

Lassen Junior College, Division of Vocational Forestry and Lumbering, Susanville, Calif.

University of Maryland, Department of Horticulture, College Park, Md.

North Dakota Agricultural College, Department of Horticulture and Forestry, Fargo, N. Dak.

North Dakota School of Forestry, Bottineau, N. Dak.

Northwestern State College, Agriculture Department, Natchitoches, La.

Ohio State University, Department of Horticulture and Forestry, Columbus 10, Ohio.

Paul Smith's College, Forestry Department, Paul Smiths, N. Y.

Pasadena City College, Pasadena 4, Calif.

Rutgers University, Department of Forestry, New Brunswick, N. J.

University of Tennessee, Department of Horticulture and Forestry, Knoxville 16, Tenn.

Texas A & M College, Department of Range and Forestry, College Station, Tex.

University of Vermont, College of Agriculture, Burlington, Vt.

University of Virginia, School of Forestry, Charlottesville, Va.

Wisconsin State College, Botany Department, Superior, Wis.

University of Wisconsin, College of Agriculture, Madison, Wis.

Ranger Schools

State Forest Ranger School of the University of Florida, Lake City, Fla.

State Ranger School of State University College of Forestry, Wanakena, N. Y.

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when overtopping hardwoods
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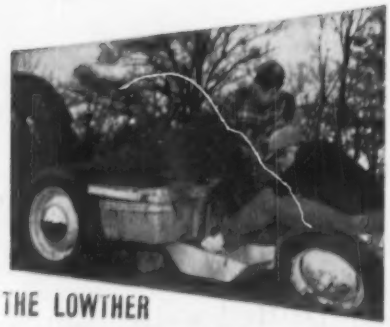

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MEMBERS of the Puget Sound Section who met at Wenatchee, Wash. in February to organize the Mid-Columbia Chapter. This chapter will comprise S.A.F. members in Chelan and Okanogan Counties in north central Washington, east of the Cascade Mountains.

Third Call for Council Nominations

All voting members are hereby notified that the regular biennial election will be held December 3, 1955. A president, vice president, and nine other members of the Council will be elected for the two-year term 1956-1957.

The present Council is listed in the box on page 376. Any or all of these incumbents may be renominated, provided they accept the nomination in writing.

President Demmon has announced that he will not be a candidate for re-election.

Membership on the Council is restricted by the Constitution to Members (formerly Senior Members) and Fellows. Any Member or Fellow is eligible to hold office who is in good standing and who accepts the nomination in writing and declares his willingness to serve if elected.

Each voter will have an opportunity to ballot on all candidates for office. Council members are elected in accordance, with the system of proportional representation. The procedure of proportional representation will be explained in a later issue of the JOURNAL. It is the system by which the Society has been electing Council members for two decades.

Candidates for the office of president are voted on separately; the candidate who receives the highest vote is declared elected president, and the candidate who receives the next highest vote is declared elected vice president.

How Nominations Are Made

The Constitution (Article VIII, Section 2) states the conditions under which nominations are made by petition.

1. Each petition shall name but one candidate.

2. All candidates must be eligible to hold elective office.

3. A petition shall bear the signatures of at least ten voting members who at the time of signing the petition are eligible to vote in the coming elec-

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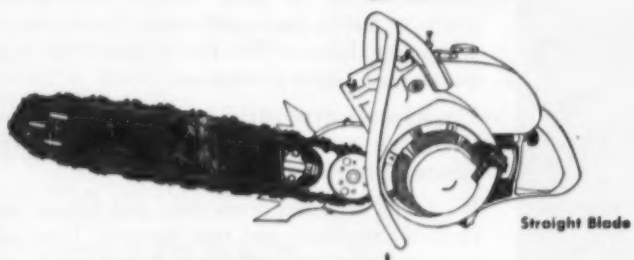

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tion. (Eligible voting members are Junior Members, Members, and Fellows in good standing.)

4. A voting member may not sign more than one nominating petition for President or more than one nominating petition for a member of the Council. That is, he may sign two, but no more.

5. Petitions must be in the Society office by October 1, 1955.

The Society has no special form for submitting nominating petitions. They may be written as follows:

We, the undersigned voting members of the Society of American Foresters, hereby nominate John Doe, a Member (or Fellow), for the office of President (or member of the Council) for the two-year term 1956-1957.

All nominating petitions should be sent promptly to the Society office. The executive secretary will gladly provide information about nominating or election procedure.

Nominations Received

On the date this issue went to press the following nominations had been received.

For President: DeWitt Nelson, Sacramento, Calif. (Vice president, 1954-1955.)

For the Council: B. E. Allen, Savannah, Ga.

N. T. Barron, Franklin, Va.

C. H. Coulter, Tallahassee, Fla. (Council member, 1954-1955.)

E. F. Heacox, Tacoma, Wash. (Council member, 1954-1955.)

William P. House, Cheshan, N. H.

Henry J. Vaux, Berkeley, Calif.

The Nominating Committee will make no nominations of its own unless the voting membership fails to make the required minimum number of nominations by petition. Voting members should accordingly get busy and make their own nominations.

A. R. BOND, *Chairman,*
Nominating Chairman

Nominations for Grade of Fellow Now Open

All Members (formerly Senior Members) and Fellows of the Society are hereby advised that nominations for the grade of Fellow are now open. The election of Fellows will be held at the time of the Society's regular biennial election, December 3, 1955.

As defined by the Constitution (Article III, Section 6), "Fellows shall be foresters of outstanding achievement as leaders in responsible directive or distinctive individual work of a fruitful character. They shall be elected from the Members and shall be engaged in forestry work at the time of their election."

OFFICERS of the Southeastern Section. *L to R;* seated, Jack T. May, Auburn, Ala., chairman; Kenneth B. Pomeroy, Lake City, Fla., past chairman; standing, Lester L. Harris, Centreville, Ala., secretary-treasurer; F. H. Robertson, Jr., Panama City, Fla., past secretary-treasurer; and James F. Spiers, Statesboro, Ga., vice chairman.

The Southeastern Section, numerically the largest of the 21 Sections, contains more than 1,000 members in Alabama, Florida, and Georgia.

Nominations by Petition

The procedure for placing Members in nomination for the grade of Fellow is by petition. The Society has no printed form for this purpose; the petition may be typewritten thus:

We, the undersigned Members and Fellows of the Society of American Foresters, hereby nominate ———— for election to the grade of Fellow in 1955.

Remember these simple rules:

1. A petition may not name more than one candidate.

2. It must be signed by 25 Members

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A Post Hole Auger designed for one man operation, doing the work of heavy equipment diggers, holes quickly and easily made in any soil type. Wood auger may be attached for wood drilling.

HAYNES TREE GIRDLER

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or Fellows in good standing.

3. It should be accompanied by a factual, not eulogistic, biographical sketch of at least 200 words giving an account of the nominee's professional career and accomplishments.

4. It must be received in the executive office of the Society in Washington, D. C., not later than October 1, 1955.

The executive employees of the Society cannot be responsible for obtaining signatures on partially completed petitions or on petitions incomplete by reason of unacceptable signatures (that is, signatures of other than Members and Fellows in good standing).

Nominations Received

On the date of going to press, the following Members had been nominated for the grade of Fellow:

S. B. Detwiler, Colo.

Frank H. Kaufert, Minn.

Election Procedure

Fellows are not elected by the membership at large, but by a board of electors which consists of all present Fellows and the present Council. (A Council member who is also a Fellow has but one vote.)

To win election a candidate must receive an affirmative vote of not less than one-half the total votes cast.

Significance of the Grade

The highest membership distinction that can be conferred by the Society, this grade is awarded in recognition of outstanding achievement. Fellows do not pay increased dues; their dues are the same as those of Members.

Since the Society was founded in 1900, there have been 100 Fellows elected. At the present time the number of living Fellows is 69.

Since the last election in December 1953, two Fellows have died:

Elers Koch and E. A. Sterling.

The current roster of Fellows appears on page 222 of the March issue of the JOURNAL.

Vern H. Thaler (1913-1955)

Vern Hill Thaler, a district forester with the Michigan Department of Conservation at Gaylord, died of a heart attack on January 3.

He was born November 12, 1913. Graduating in forestry at Michigan State College in 1939, he was an administrative assistant with the College until he entered the Army in 1941, serving with the Field Artillery as an officer until 1946.

On his return to forestry he went with the Michigan Department of Agriculture, and transferred to the Department of Conservation in 1950.

Wisconsin-Michigan Holds Section Meeting

At a meeting of the Wisconsin-Michigan Section held March 4 and 5 at Wausau, Wis. the members voted on several important items of business:

An honorarium of $100 will be paid annually to the secretary.

The bylaws were amended to provide for a vice chairman of the Section, an office not previously set up.

The term of office of the Section officers will be from July 1 to June 30.

The bylaws were amended to change the Section's name to Wisconsin-Michigan instead of Wisconsin-Upper Michigan. In addition the geographical limits of the Section were officially changed to include the Lower Peninsula of Michigan.

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Frank Alvah Kittredge (1883-1954)

Frank A. Kittredge, engineer and Associate Member of the Society of American Foresters, died at his home in Palo Alto, Calif., December 10, 1954.

Born in Glyndon, Minn., March 29, 1883, he received the B.S. in C. E. degree from the University of Washington in 1912 and C. E. in 1915.

He entered the National Park Service, Department of the Interior, as chief engineer in 1927, with headquarters in San Francisco. When that Service became regionalized, he served as regional director, San Francisco, 1937-1940; superintendent, Grand Canyon National Park 1940-1941: superintendent, Yosemite National Park 1941-1947; chief engineer, Washington, D. C., 1947-1952. Retired May 31, 1952.

During World War I he served in France as 1st lieutenant with the Forestry Regiment, and then as captain, Road and Bridge Engineers, U. S. Army.

New officers elected for the period July 1, 1955 to June 30, 1956 are:

Chairman, Dan E. Bulfer, 123 No. Baird Avenue, Rhinelander, Wis.

Vice chairman, T. D. Stevens, Department of Forestry, Michigan State College, East Lansing, Mich.

Secretary-treasurer, Paul R. Flink, 523 Maplewood Court, Kingsford, Mich.

The summer meeting will be held at Sault Ste. Marie, Michigan; date not yet determined.

The technical session contained a panel discussion of forest inventories in the two states. J. B. Millar acted as moderator.

At the Section dinner, Will Brown was toastmaster. The speaker was Forster Cooper whose subject was "Human Relationships in Forestry."

Allegheny Section Holds Winter Meeting

The winter meeting of the Allegheny Section was held at the Hotel William Penn, Pittsburgh, Pa., on February 25 and 26, 1955.

The theme was forest and water conservation. Keynote speaker on the Friday program was Prof. Maurice Brooks of West Virginia University. He was followed by Howard Lull of the Northeastern Forest Experiment Station, who presented a paper "Why Forests Are Important." Sidney A. Weitzman of the Mountain State Research Center told of the "Management of Forests for Water Conservation," illustrating it with slides taken at the Fernow Experimental Forest.

Dean Harley Bond, head of the Biology Department of Salem College spoke in "Small Watersheds-The New Approach" and told of the work on the Upper Ten Mile watershed, a pilot watershed. Regional Forester Charles Tebbe reported on the fiftieth anniversary of the Forest Service.

Friday afternoon was devoted to the business meeting. Chairman Austin N. Lentz reported on Society Affairs and the Milwaukee meeting. Dean Samuel Dana reported on the new journal, *Forest Science*, and urged the members to support it. At the Friday evening banquet, E. J. Schreiner acted as toastmaster and introduced the officers, guests and the speaker, George Philips, of the Soil Conservation Service, who talked on the Small Watersheds Act. At the conclusion of the banquet, the tellers committee submitted its report and the following officers were installed:

Chairman, Arthur L. Bennett.

Vice Chairman, Dr. William C. Bramble.

Secretary-Treasurer, William A. Parr.

Executive Committee, David W. Sowers, Jr. and Ralph Wible.

Membership Chairman, Dr. William C. Bramble.

The Saturday program was a panel discussion "How to Develop Recognition of Forests in Water Conservation." Moderator was Walter C. Gumbel and panel members were Howard Bennett, Graham Netting, Ted Fearnow, and Harry W. Dengler.

The summer meeting will be held at Elkins, W. Va., on August 5 and 6, 1955.

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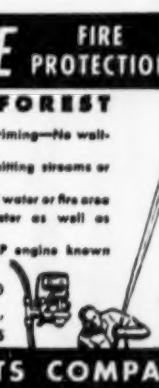

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Allegheny Section Conducts Membership Opinion Poll

Last year the chairman of the Allegheny Section appointed a special Planning Committee to study Section activities and make recommendations as to how the Section can better serve the members.

The personnel of the Committee consists of John J. Mohr of Maryland, Darwin B. Palmer of Delaware, E. Clyde Pyle of Pennsylvania, Ralph O. Smoot of West Virginia, and Gordon T. Bamford of New Jersey, chairman.

An opinion poll of the Section members was obtained through a mail questionnaire. Because the results of the questionnaire are so interesting, the replies are published herewith in the belief that they may be applicable to other Sections also.

The Committee summarized the suggestions received in answer to each individual question. They are presented in descending order of importance as determined by the number of times the same comment or suggestion appeared. The value of some of the last stated suggestions must not be minimized, the Committee points out, because some excellent ideas came from only one source.

The questions and answers follow.

1. What service do you want, or expect from the Section?

Interchange of ideas and information on latest developments and equipment in forestry.

Services adequate, satisfied with present organization.

More news of Section affairs including what Section officers are doing.

More activity on job placement.

More activity and information in the utilization and marketing phases of forestry.

Good fellowship.

More public relations work in name of profession.

Annual roster of members including brief statement about nature of members' position.

Greater dissemination of information from research which cannot be covered by publication in the JOURNAL OF FORESTRY.

S.A.F. to promote conservation nationwide.

Closer tie of Sections on national level for action and information helpful to all members.

Section should strongly support Civil Service in Pennsylvania.

2. What suggestions can you give that would further increase the value of Section activities to you?

More complete coverage in the Allegheny News.

Have Section endorse and actively promote registration of foresters.

More, smaller, localized summer meetings.

Have meetings near geographical center of Section.

Encourage more chapters.

Opportunity for younger members to participate in affairs.

More student participation by supplying speakers for schools.

Short courses on forestry subjects at the forestry schools in the Section.

Recirculate by-laws every 2 or 3 years.

More emphasis on forest recreation.

3. Do you think that you are participating enough in Section affairs?

No—59 percent.

Yes—41 percent.

If not, would you like to take a more active part if given the chance?

Yes—71 percent.

No—29 percent.

(Continued on page 386)

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To this end, Delaware Forestry Dept. maintains a cooperative forest management service, available without charge to all woodland owner and wood processors. This service urges and aids a program of protection and skillful management—centering around reclamation, through elimination of wolf and weed trees, culls and diseased timber, and reforestation, by provision for natural seeding and planting.

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4. What are your suggestions for better meetings?

More panel discussions with questions from the floor.

Have speakers, and panel members, speak concisely and within the allotted time.

Have a general meeting with more diversified subject matter, rather than a "theme."

More time for discussion after a paper is presented.

Better timing, i.e. adherence to schedule, at meetings.

Prior to meetings publish whole or summary of papers to be presented and then devote all or substantial amount of time at meeting to discussion.

Discuss "live issues" of a controversial nature, i.e. prescribed burning, civil service versus executive appointment, federal or state regulation of forestry, etc.

Winter meetings to be broken up by a short visit to wood-using industry.

Good speakers, who speak from notes rather than read a paper.

Don't try to crowd in too much.

More member participation.

More unscheduled time for "technical bull sessions."

Keep dates of meetings more regular.

Opportunity for "unknowns" to meet unknowns.

Shorter and more frequent meetings throughout various areas of Section.

Exhibitions of equipment, books, and pamphlets at meetings.

Rotate location of meetings.

Occasional meetings with allied organizations.

Short, informal discussion of one timely, pertinent topic immediately following luncheon at summer meeting.

Outstanding speaker of national reputation at winter meeting.

Invite outsiders to participate in special topics such as watershed management, wood utilization, soils, soil conservation, etc.

Try divisionalizing a meeting with two or more subject matters being presented simultaneously thereby appealing to more interests and encouraging more discussion through smaller groups.

More emphasis on private forestry with view of encouraging more foresters in private industry to participate.

5. Do you think that all papers presented at meetings should be recorded as a part of the Allegheny News?

No—59 percent.

Yes—41 percent.

Or should they be published in a separate edition immediately following the winter meeting?

Yes—65 percent.

No—35 percent.

6. Do you attend meetings regularly?

No—60 percent.

Yes—40 percent.

If not, why?

Conflicts with job.

Too expensive.

Personal reasons.

Lack of interest in certain subject matter.

Not always convenient for traveling and time.

7. Would you prefer that Section meetings be held on Thursday and Friday instead of on Friday and Saturday?

No—56 percent.

Yes—44 percent.

8. Do you believe that the elected officers of your Section should serve for a period of two years instead of

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the one year term now in effect?

Yes—66 percent.

No—34 percent.

Comments:

Pro. Will result in increased efficiency through officers knowing their job better.

Con. 1. Will decrease turnover thereby reducing member participation.

2. Work in Section affairs imposed on officers, particularly chairman, in addition to regular position too much for a two-year period. (Ask any ex-chairman.)

9. Do you favor having the Section treasury bear, or partially defray, the expenses incident to the necessary trips expected of the Chairman? (This reimbursement, of course, would not include the regular summer and winter Section meetings or Chapter Meetings of the Chairman's home Chapter.)

Yes—89 percent.

No—11 percent.

If the Section treasury will not cover such an expense, would you be in favor of having the Section dues raised a nominal amount (i.e., an increase of 25 cents or 50 cents).

Yes—81 percent.

No—19 percent.

Comments: Please indicate any other ideas you might have on how the Section can better serve you.

Committee members should serve two or more years in overlapping terms.

Assure that the Section as a whole maintains a balanced view of public and private forestry.

The Section should set up a central job or personnel committee where members knowing of jobs can send in information, while members looking for new employment can have their name and qualifications on file. Would benefit both members and employers of foresters.

A brief report, to the members by the chairman, in the Allegheny News on what the committees are doing.

A new standing committee on research.

Expand Allegheny News to not more than four issues to include more articles on minor research and studies.

Bring up to date the Allegheny Section history and publish.

Publish in Allegheny News list of current publications on forestry and related fields applicable to conditions within the Section.

If member fails to attend a minimum number of meetings during a specified period, he should be reduced to an inactive status (Note: question of policy at national level?)

A fire protection committee.

Two members of the Section from West Virginia indicate that perhaps Chapter affairs in their state are replacing rather than augmenting interest in the Allegheny Section and parent Society.

Recommendations.

As a result of the opinions expressed by a sample of the membership, we respectfully submit the following recommendations to the Executive Committee for consideration:

1. A copy of this report be made available to the chairmen of all committees and the editor of the Allegheny News as there are ideas and suggestions pertaining to all phases of Section affairs.

2. The question of a one versus a two-year term for the elected officers should be given more consideration. The membership answering the questionnaire clearly indicated an approval of a two-year term. There is, however, evidence that many who

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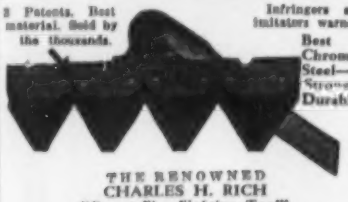

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favored a two-year term on the grounds that it would make for increased efficiency are unaware just how close an officer is to all phases of Society affairs in coming up through the ranks to chairman.

3. Appropriate action be taken to establish a policy for reimbursing the chairman for travel expenses incident to his duties.

4. The names of the members indicating their desire to be more active in Section affairs be sent to the chairmen of Chapters in those states concerned.

THE COMMITTEE

How Young are the Foresters in New York State?

A total of 25,600 earned degrees in forestry have been awarded in the United States since 1900, when the first earned forestry degree (Bachelor of Science in forestry) was awarded by Cornell University. The following table lists by decades the number and the percentage of earned forestry degrees that have been awarded in the United States during the five full decades from 1900 to 1949 and the four-year period of 1950 to 1953:

Decade	Number of earned degrees granted in forestry	Percent of total number
1900-1909	363	1.4
1910-1919	1,481	5.7
1920-1929	2,708	10.6
1930-1939	6,413	25.1
1940-1949	7,431	29.0
1950-1953	7,204	28.2
Total	25,600	100.0

It is highly significant that more than 82 percent of the forestry degrees granted in the United States during the past fifty-four years, have been awarded since 1930. Also highly significant is the fact that more than one-half of all these forestry degrees, to be exact 54.1 percent, were awarded during the two decades from 1930 to 1949. The men who received these degrees have now had an opportunity to have had from 5 to 25 years of service in forestry. And of even greater significance is the inspiring fact that these men comprise not only the numerical majority of the professionally trained foresters now serving in the United States, but also constitute the main strength and promise of good forestry in the future.

The 1954 summer meeting of the New York Section of the Society of American Foresters was held at Letchworth Park in the western part of the state. Some sixty foresters, woodland owners and operators participated in an all-day field trip, during which special consideration was given to the effective handling of northern hardwood forest areas.

A novel feature of the banquet session of this meeting, perhaps not heretofore featured at any Section meeting of the Society was a simple survey of the age-classes of the foresters in attendance. Each of the 54 foresters participating in the banquet was asked to record his age on the back side of his banquet ticket. (Everybody cooperated.) The following extremely interesting data came forth from this simple and innocuous sampling of the ages of foresters now functioning in New York State:

Age range (years)	Number of foresters	Percent of total
Below 30	4	7.4
30-39	23	42.7
40-49	18	33.3
50-59	5	9.3
60-69	2	3.7
70-79	1	1.8
80 and over	1	1.8
Total	54	100.0

It is worthy of serious thought that almost 43 percent of the foresters in attendance at this meeting were in the age-class of 30 to 39 years, and that 76 percent were in the age-class of 30 to 49 years. It is quite probable that a nation-wide survey would show that the bulk of the work in American forestry is now being done by foresters in these relatively young age groups.

Equally interesting was the age-range of the participating foresters. It ranged all the way from 21 to 80 years. The youngest forester attending the meeting (Murray Valentine) is a graduate of the New York State College of Forestry at Syracuse (class of 1954), and now employed in the Woodlands Department of the Newton Falls Paper Company at Newton Falls, New

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York. The senior member at the meeting was Professor Ralph Hosmer, now professor emeritus of Forestry at Cornell University, and one of only two living charter members of the Society of American Foresters, founded in Washington, D. C. in 1900. Perhaps there has not been, and there may never again be, a section meeting of the Society of American Foresters with such a wide age-span (21 to 80 years) among the foresters in attendance, especially with a charter member holding the top-age position, for there remain with us only two of the original seven charter members of our Society.

Note: This statement is contributed with the hope that it may stimulate additional contributions regarding the human aspects of forestry.

JOSEPH S. ILLICK

Membership Applications and Advancements

Proposals for admission, advancement, and reinstatement received in the Society office during the month of March are listed below.

Action on the eligibility of those proposed for membership as listed below will be taken by the Council as of June 1, 1955. Communications from voting members regarding the membership eligibility of these persons should be received in the Society office prior to that date.

Allegheny Section

Student Grade

PENNSYLVANIA STATE UNIVERSITY

Bailey, S. A. Orvis, L.

WEST VIRGINIA UNIVERSITY

Bishop, D. D.

Junior Grade

Nielsen, H. K., 54 Randolph Road, Plainfield, N. J. Reinstatement.

Norris, T. G., Chief, Dept. Forests & Waters, Fayetteville, Pa. Reinstatement.

Schneider, J. E., 113 Meem Ave., Gaithersburg, Md. Reinstatement.

Wills, D. E., Forester, Pa. Dept. Forests & Waters, Coudersport, Pa.; Pa. State, B.S.F., 1950.

Younkin, P. B., Asst. Dist. Forester, Pa. Dept. Forests & Waters, Mt. Union, Pa., Pa. State, B.S.F., 1950.

Member Grade

August, W. A., 1122 N. 17th St., Harrisburg, Pa. Reinstatement.

Middour, J. C., Forester, Pa. Dept. Forests & Waters, Harrisburg, Pa. Reinstatement.

Appalachian Section

Junior Grade

Alvis, R. J., Box 546, N. Wilkesboro, N. C. Reinstatement.

Carter, W. M., Forester, Va. Forest Service, Charlottesville, Va.; V.P.I., B.S., (Forestry), 1952. (Affiliate, 1953).

Hurlbut, B., Box 298, Walterboro, S. C. Reinstatement.

Smith, D. R., 14-D Vetville, State College Station, Raleigh, N. C.; N. C. State, B.S.F., 1955. (Student, 1954).

Member Grade

Aldrich, R. C., 5029 Muskogee St., College Park, Md. (Junior, 1948).

Babbitt, R. T., Forester, S. D. Forbes, Inc., Charlottesville, Va. (Junior, 1948).

Berry, R. M., Forester, U. S. Naval Ammunition Depot, Charleston, S. C. (Junior, 1948).

Blain, G. I., Forester, Va. Forest Service, Fredericksburg, Va. (Junior, 1948).

Brown, C. A., Asst. Div. Supt., International Paper Co., Georgetown, S. C. (Junior, 1948).

Chastain, V. T., Forester, W. Va. Pulp & Paper Co., Summerville, S. C. (Junior, 1948).

Conrad, J. L., Tbr. Buyer, Wellford Bros. & Fryer, Hillsboro, N. C. (Junior, 1947).

Erb, D. H., Cons. Forester, W. Va. Pulp & Paper Co., Covington, Va. (Junior, 1947).

Estes, G., Asst. Prof., Univ. of Va., Triplet, Va. (Junior, 1948).

Marler, R. L., Asst. Chief, Reforestation, Va. Forest Service, Charlottesville, Va. (Junior, 1948).

McBeth, A. R., Woodyard Supt., Riegel Carolina Corp., Acme, N. C. (Junior, 1947).

Pennock, C. M., Dist. Mgmt. Chief, Va. Forest Service, Richmond, Va. (Junior, 1948).

Richardson, R. R., Asst. Woodlands Mgr., Riegal Woodlands Corp., Bolton, N. C. (Junior, 1948).

Roberts, C. W., Field Asst., International Paper Co., Siler City, N. C. (Junior, 1948).

Tofte, A. L., 27 Winthrop Dr., Aiken, S. C. Reinstatement.

Wallace, W. S., Plant Mgr., Gramwood of N. C., Inc., Clarkton, N. C. (Junior, 1948).

Affiliate Grade

Carter, M. C., Grad. Asst., V. P. I., Blacksburg, Va.; V.P.I., B.S., (forestry), 1955.

Central Rocky Mountain Section

Student Grade

COLORADO A & M COLLEGE

Chapparo, W. J.

Central States Section

Affiliate Grade

Tompkins, A. S., Mgr., A. C. Miller Co., Delaware, Ohio.

Columbia River Section

Junior Grade

Beckim, G. A., Dist. Warden, Box 646, Vancouver, Wash. Reinstatement.

Betts, R. E., Forester, Bur. of Land Mgmt., Eugene, Ore.; Colo. A & M, B.S.F., 1954.

Fogelquist, C. F., 9320 S. W. Oleson Rd., Portland, Ore. Reinstatement.

Gardner, G. A., Land Surveyor & Cruiser, 1643 W. Main, Cottage Grove, Ore.; Ore. State, B.S.F., 1947.

Gustafson, H. W., Dist. Ranger, U.S.F.S., Sisters, Ore.; Ore. State, B.S.F., 1936.

Heaney, S. J., Unit Forester, Bur. of Land Mgmt., Salem, Ore.; Univ. of Idaho, B.S.F., 1940.

Kerr, C., Owner, Engineering & Cruising Services, Roseburg, Ore. Ore. State, B.S.F., 1924.

Leavitt, K. R., 957 Jefferson St., Corvallis, Ore.; Ore. State, B.S.F., 1954. (Student, 1954).

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Scott, F. W., Scottsburg, Ore. Reinstatement.
Houle, L. T., Forestry Aide, U.S.F.S., Mckenzie Bridge, Ore.; State Univ. of N. Y., B.S.F., 1952.
Stevens, G. J., Box 120, Glenwood, Wash. Reinstatement.

Member Grade

Bond, F. L., Dist. Ranger, U.S.F.S., Estacada, Ore. (Junior, 1948).
Doerr, R. W., Owner Mgr., Doerr Lbr. Co., Eugene, Ore. (Junior, 1948).

Associate Grade

Corthell, R. A., Dist. Game Agent, Ore. State Game Comm., Coos Bay, Ore.; Ore. State, B.S., (Fish & Game Mgmt.), 1948; M.S., 1950.
Costello, D. F., Chief, Div. of Rge. Mgmt. Research, U.S.F.S., Portland, Ore.; Univ. of Chicago, M.S., (Plant Ecology), 1925; Ph.D., 1934.
Irgens-Moller, H., Grad. Asst., Ore. State, Corvallis, Ore.; Royal Vet. & Agric. College, Denmark, B.S., (Hortic. Dendrology), 1949.

Gulf States Section

Student Grade

LOUISIANA POLYTECHNIC INSTITUTE

Bailiff, T. C.
Bryan, R. W.
Edmondson, J. H.
Joffrion, L. E.
Keith, J. G.
Larance, C. E.
Perry, V. K.
Reese, J. B.
Thompson, C. R.

LOUISIANA STATE UNIVERSITY

Bates, J. C.
Bowers, J. W.
Cronton, E. F.
Griffin, J. W.
Guillory, G. B.
Jordan, F. M.
Maxwell, J. E.
Murray, L.
Norton, C. M.
Slade, W. L.
Trewolla, W. P.

Junior Grade

Giaquinto, E. J., 922 Hardy St., Hattiesburg, Miss. Reinstatement.
McDaniel, C. M., Dist. Forester, La. Forestry Comm., Minden, La. Reinstatement.
Williams, G. J., Box 125, Pattison, Miss. Reinstatement.

Affiliate Grade

Batson, F. S., Tree Farmer, Box 54, Wiggins, Miss.; Miss. State, B.S., (Horticulture), 1929; Ohio State, M.S., (Floriculture), 1934.
Biskamp, L. A., Field Forester, Lutcher & Moore Lbr. Co., DeQuincy, La.; Stephen F. Austin State College, B.S., (Forestry), 1950.
Lyons, L. O., Project Forester, U.S.F.S., Carrollton, Miss.; V.P.I., B.S., (Forestry), 1952.
Young, L. O., Field Asst., International Paper Co., Carthage, Miss.

Inland Empire Section

Student Grade

UNIVERSITY OF IDAHO

Sandmeyer, J. D.

Junior Grade

Morgan, R. S., Dist. Ranger, U.S.F.S., Moscow, Idaho. Reinstatement.

Intermountain Section

Member Grade

Van Winkle, H. [illegible]..53 28th St., Ogden, Utah. Reinstatement.

Affiliate Grade

Crezee, D. B., Research Forester, U.S.F.S., Ogden, Utah; Utah State Agric., B.S. (Range Mgmt.), 1954.

New England Section

Student Grade

UNIVERSITY OF MASSACHUSETTS

Leslie, R. E.
Lonn, V. R.

YALE UNIVERSITY

Hollingsworth, S.

Junior Grade

Winter, G. H., 6 Thomas St., Bucksport, Maine. Reinstatement.

New York Section

Student Grade

STATE UNIVERSITY OF NEW YORK

Eastbury, P. O.
Serino, R. G.

Junior Grade

Peet, O., Machine Draftsman, The Haloid Co., Pittsford, N. Y.; Cornell Univ., B.S.F., 1935.

Affiliate Grade

Wheeler, S. A., Forester, Otsego County, East Springfield, N. Y.

Associate Grade

Nichols, J. D., Lab. Scientist, Dept. Lands & Forests, Willowdale, Ont. Canada.; Ont. Agric. College, B.S., (Field Husbandry), 1947.

Northern California Section

Student Grade

UNIVERSITY OF CALIFORNIA

Annand, P. G.

Junior Grade

Backlund, A. J., 1442 Chester Ave., Arcata, Calif. Reinstatement.
Levine, J., Thr. Sale Supv., Arcata Plywood Co., Arcata, Calif. Reinstatement.
Rankin, A. W., 3122 13th St., N. Sacramento, Calif. Reinstatement.
Schlapfer, T. A., Dist. Ranger, U.S.F.S., Mt. Hebron, Calif. Reinstatement.

Northern Rocky Mountain Section

Student Grade

MONTANA STATE UNIVERSITY

Ortengren, R. E.

Affiliate Grade

Evans, P. G., Fire Control Aide, U.S.F.S., Libby, Mont.
McConnell, E., Forester, Mont. State Univ., Missoula, Mont.
Neils, R. L., Logging Supt., J. Neils Lbr. Co., Libby, Mont.
Tarbet, L. M., Chief Fire Warden, Lumbermen's Info. Bur., Missoula, Mont.

Associate Grade

Jones, H. R., Asst. Regional Forester, U.S.F.S., Missoula, Mont.
Koessler, H. H., President, Intermountain Lbr. Co., Missoula, Mont.

Ozark Section

Student Grade

UNIVERSITY OF MISSOURI

Hilliard, R. E.

Associate Grade

Bretz, T. W., Prof., Dept. of Forestry, Univ. of Mo., Columbia, Mo.; Ohio State, B.S., (Agric.), 1930; Iowa State, M.S., (Mycology), 1931; Ohio State, Ph.D., (Plant Pathology), 1937.

Puget Sound Section

Student Grade

UNIVERSITY OF WASHINGTON

Olson, O. N.
Smith, I. E.
Spangler, W. E.

Junior Grade

Franz, G. H., Forestry Aide, U.S.F.S., Twisp, Wash.; Univ. of Wash., B.S.F., 1950.
Landon, D. E., Forester, Crown Zellerbach Corp., Port Angeles, Wash.; Univ. of Wash., B.S.F., 1950.
Longmoor, J. E., Dist. Ranger, U.S.F.S., Twisp, Wash. Reinstatement.
McAninch, G. E., Box 411, Monroe, Wash. Reinstatement.
Reasoner, H. A., Forester, Columbia Valley Lbr. Co., Bellingham, Wash. Reinstatement.
Sylvester, R. A., Forester, Dept. of Interior, White Swan, Wash.; Utah State Agric., B.S.F., 1950.

Affiliate Grade

Burgess, F. W., Forester, U.S.F.S., Port Angeles, Wash.; Wash. State, B.S., (Forestry), 1949.
Dinehart, P. D., Forester, Dept. of Interior, Toppenish, Wash.; Wash. State, B.S., (Forestry), 1951.
Simonton, E. W., Forester, Anderson & Middleton Lbr. Co., Aberdeen, Wash.; Wash State, B.S., (Forestry), 1933.
Vogel, W. J., Forester, Dept. of Interior, Toppenish, Wash.; Wash. State, B.S., (Forestry), 1950.

Southeastern Section

Student Grade

UNIVERSITY OF FLORIDA

Hinkle, E. H.
Mackay, W. R.

Junior Grade

Levi, A. C., Field Asst., International Paper Co., Bay Minette, Ala.; A.P.I., B.S.F., 1950.
Pigg, C. A., 306 N. Kirkman St., Florence, Ala.; A.P.I., B.S.F., 1955. (Student, 1953).
Toney, F. M., Box 431, Waycross, Ga. Reinstatement.
Trevison, A. G., Area Mgr., Box 367, Ludowici, Ga.; W. Va. Univ., B.S.F., 1952.

Southwestern Section

Junior Grade

Weskamp, F. R., Partner & Gen. Mgr., Wolfe Lbr. Co., Magdalena, N. Mex.; Mont. State, B.S.F., 1950.

Affiliate Grade

Anderson, C. J., Forester, U.S.F.S., Williams, Ariz.
Proctor, G. R., Forester, U.S.F.S., Grants, N. Mex.; Univ. of Ariz., B.S., (Rge. Ecology Botany), 1946.

Upper-Mississippi Valley Section

Student Grade

IOWA STATE COLLEGE

Clauson, R. D.
Hunt, R. L.

UNIVERSITY OF MINNESOTA

Ginnaty, T. P.
Rudolph, T. D.
McCutchen, L. R.

Junior Grade

Clark, W. P., Student, Iowa State, Ames, Iowa; Iowa State, B.S.F., 1952.
Isaacson, W. R., Dist. Ranger, U.S.F.S., Bena, Minn.; Univ. of Minn., B.S.F., 1932.
Pfankuch, D. J., Mgmt. Forester, Minn. Dept. of Cons., Preston, Minn.; Univ. of Minn., B.S.F., 1950.

Washington Section

Junior Grade

Lewis, R. G., 4925 N. Wash. Blvd., Arlington, Va.; V.P.I., B.S., (Forestry), 1953; Ore. State, M.F., 1954.

Wisconsin-Michigan Section

Student Grade

MICHIGAN STATE COLLEGE

Basinger, J. A.
Middlewood, H. B.

UNIVERSITY OF MICHIGAN

Calkins, P. S.
Whitmore, F. W.
Jones, R. D.

Junior Grade

Besse, J. D., 529 Lake St., Sault Ste. Marie, Ont. Canada. Reinstatement.
Prior, J. W., Box 426, Delafield, Wis.; Mich. State, B.S.F., 1954. (Student, 1952).

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Forestry News

Henry Vaux Appointed California Dean

The appointment of Henry J. Vaux as dean of the University of California School of Forestry was recently announced. Dr. Vaux will assume office July 1, replacing Frederick S. Baker, who asked to be relieved to devote full time to teaching and research. Baker has been dean since 1949. He is eligible to retire in two years.

Dr. Vaux joined the University faculty in 1948 as lecturer in forestry, after transferring from the California Forest and Range Experiment Station. He became associate professor in 1950 and full professor in 1953.

The 42-year-old forest economist was born in Bryn Mawr, Pa. He was graduated from Haverford College and received his Master of Science and Doctor of Philosophy degrees from the University of California.

During World War II he was an intelligence specialist for the U. S. Army Air Force. In 1943 he joined the U. S. Naval Reserve and served actively until 1946, when he became a forest economist for the U. S. Forest Service.

Dean Baker came to the University in 1926. He was made acting dean of the School of Forestry in 1947, shortly after it was set up as a separate school, and became dean in 1949.

The incoming dean belongs to the Society of American Foresters, is past chairman of its northern California section, and is presently chairman of its Division of Forest Economics and Policy. He was co-editor of a reference book, *Research in the Economics of Forestry.*

HENRY J. VAUX

W. R. Hine, A. J. Jaenicke Receive Nash Awards

Two members of the Forest Service were among 10 professional workers in conservation receiving 1955 Nash Conservation Awards.

Willard R. Hine was honored for his work as assistant regional forester in charge of the Division of Information and Education, Southern Region, U. S. Forest Service, Atlanta, Ga.

Alexander J. Jaenicke, Portland, Ore., was cited for his important work in forest insect control throughout the West.

The Nash Conservation Awards, made annually by the Nash Motors Division of the American Motors Corp., were announced this year during the 20th North American Wildlife Conference, held March 14-16 in Montreal.

Record High in Tree Planting Reported

The Department of Agriculture announces an all-time high in forest and shelterbelt tree planting for the fiscal year ending June 30, 1954. The report was compiled by the Forest Service from statistics sent in by its field offices, other federal agencies, and state foresters.

The 811,066 acres planted between July 1, 1953 and June 30, 1954, is an increase of 13 percent over the planting in fiscal year 1953. Of the total planted, 687,338 acres were in private ownership, 45 percent of which is owned by forest and other industries. The federal government planted 73,017 acres and the states and other nonfederal public agencies planted 50,711.

These compare to a total of 715,548 acres planted in 1953 of which 77,612 were federal lands, 63,791 were other nonfederal public lands, and 574,145 were privately owned.

F.P.R.S. to Meet in Seattle

The Forest Products Research Society annual meeting will be held in Seattle, June 21-24. Subjects on the program for discussion cover the full scope of wood products from logging and milling to marketing. Topics for

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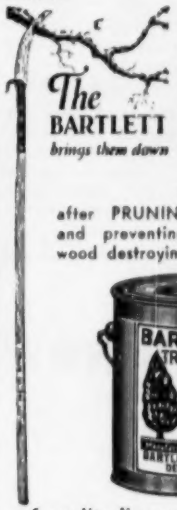

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and order at least one Nelspot gun and enough paint to prove for yourself that *"4 quarts do cost less than 1 gallon,* when you mark trees the Nelson way."
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the business sessions are being extended to cover the marketing of forest products and a highlight of the meeting will be the discussion of developments in composition boards, a relatively new product in the wood industry.

Wildlife Conference Held

The 20th North American Wildlife Conference was held in Montreal, March 14-17 with some 700 conservation technicians from the United States and Canada in attendance. The conference theme was "Natural Resource Use—A Continental Challenge."

Numerous foresters participated in the general and technical sessions.

Industrial & Private

$20,000,000 Newsprint Mill to be Built in Alabama

The International Paper Company has announced that Mobile, Ala., is to be the site of a new $20,000,000 newsprint mill. The mill will have a capacity of 100,000 tons of newsprint per year. It will require 365 cords of pulpwood daily and use approximately 6,000,000 gallons of pure water everyday.

It is expected to be completed and ready for initial operation by August, 1956.

D. B. Demeritt Heads Eastern Corporation Woodlands Department

A joint announcement by Harold Holden, president of Eastern Corporation of Bangor, Maine, and C. M. Hutchins, president of Dead River Company, likewise of Bangor, states that a subsidiary of Eastern Corporation has purchased for cash from Dead River Company about 60,000 acres of forest lands. The Dead River Company's extensive pulpwood business in Maine, which for some years has been headed by D. B. Demeritt of Orono, was also included in the sale to Eastern Corporation's subsidiary. This will bring under control of Eastern Corporation over 400,000 acres of timberlands in Maine and Nova Scotia.

Mr. Holden said that the subsidiary's acquisition of these lands will strengthen Eastern's timber holdings and forestry program and assure the company of an additional long-term supply of pulpwood for its pulp and paper mills at South Brewer and Lincoln, Maine. The domestic pulpwood business now carried on by Dead River Company will be gradually taken over by Eastern Corporation's subsidiary, starting May 1, 1955.

The joint announcement goes on to state that Mr. Demeritt, now vice president and manager of woodlands of Dead River Company, has been appointed vice president in charge of the Woodlands Department of Eastern Corporation, and will also continue in his present capacity with the Dead River Company. Both W. E. Eggleston, manager of woodlands for Eastern Corporation, and his assistant, W. M. McKay, will continue in their present capacities. Before coming with Dead River Company in 1946, Mr. Demeritt taught Forestry at Pennsylvania State University, Iowa State College, and for twelve years was head of the Forestry Department at the University of Maine.

Dead River Company will continue to operate its other remaining timberlands in Maine as usual. Dead River Limited, a wholly-owned subsidiary of Dead River Company, will continue its pulpwood business in New Brunswick and is not affected by this transaction.

Howard Ball Joins Staff Toronto Bank

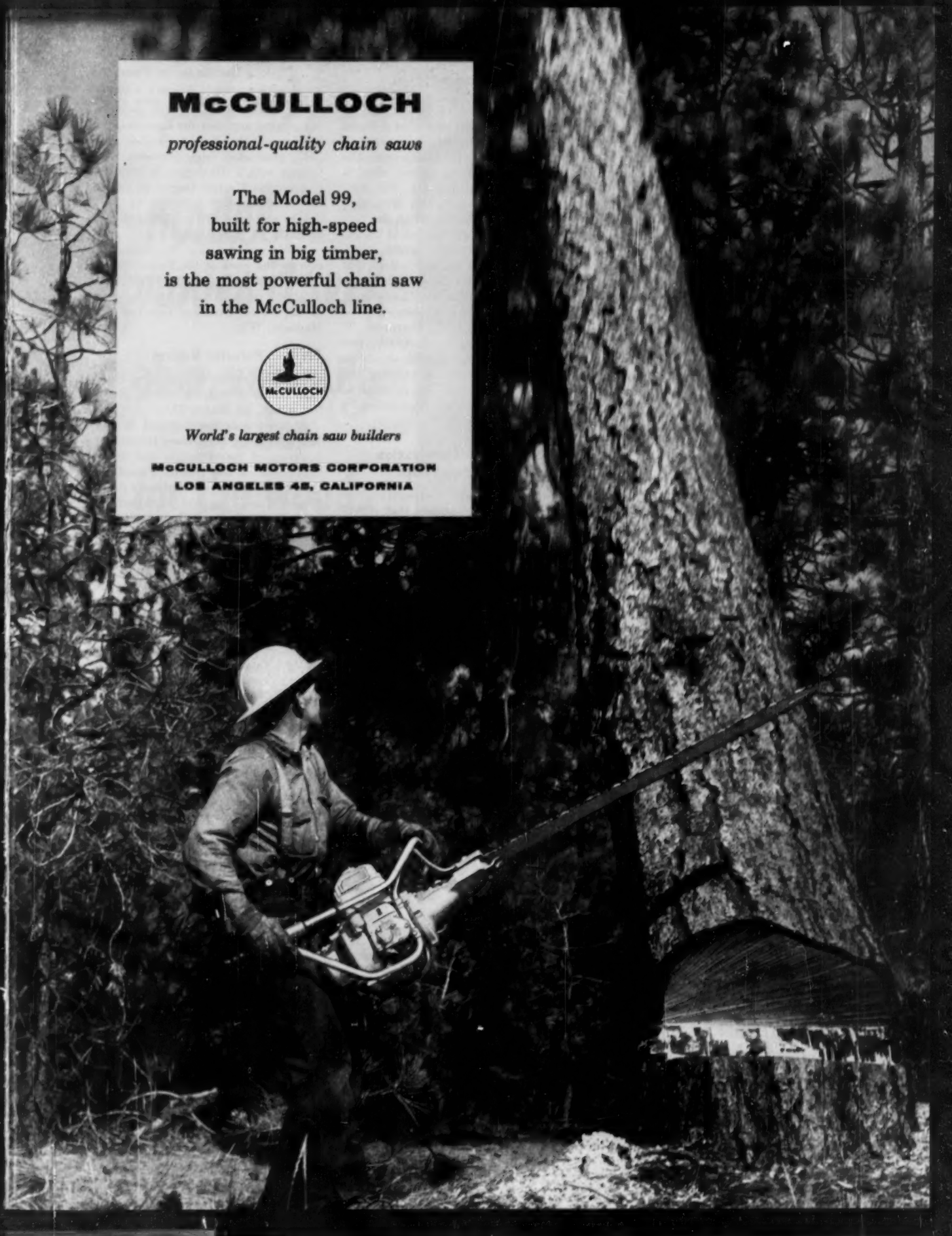
Howard E. Ball, who had been with the Budget Bureau in Washington since December 1951, left that organization in March to join the staff of the Canadian Bank of Commerce, Toronto. He will be associated with the development and organization group of the bank.

Ball has previously been with the Paley Commission and the Tennessee Valley Authority. He is a 1939 graduate of the State University of New York, College of Forestry.

Essay Contest for Western Students

The Western Forestry and Conservation Association has invited all students who will be seniors in the fall of 1955 in any of the accredited forestry schools of the West (Universities of British Columbia, California, Montana, Idaho, Washington, or Oregon State College), to prepare a short essay on some forestry subject in competition for two cash prizes. The first prize is $100.00 and the second $75.00, and in addition both winners will be invited to the annual conference of the Association, which will this year be in Portland, Oregon, on December 7-9, 1955, with all travel and hotel expenses paid.

(Continued on page 394)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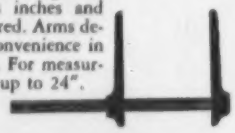

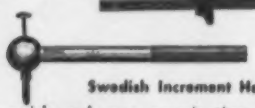

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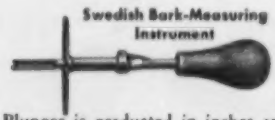

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The winner will be on the conference program to read his paper, or a digest of it, and his essay will be printed in the Proceedings of the Conference. The second prize-winning paper also is printed in the Proceedings. The winner of the contest five years previously is always invited to appear on the program and to give an account of his experiences in the forestry world.

The two essays in each school that are rated best by the faculty advisor or dean, will be sent to the Association and there rated by a committee of judges composed of Thornton T. Munger, chairman, E. T. Clark, and Arthur K. Roberts. Entries should be submitted to the deans by October 5th, so that the two best essays may be selected and sent to the Association by October 15th.

Gair Woodlands Corporation Again Offers Scholarships

Gair Woodlands Corporation of Savannah, Ga., announces that it will provide again this year two forestry scholarships. Each scholarship is for $500 per year and will be awarded for four years to the successful applicant for a total of $2,000. The two students receiving the awards will be allowed to indicate their preference to attend the University of Georgia, the University of Florida, or North Carolina State College. Continuance of the scholarship grant to any individual during the four-year period will be dependent upon his doing creditable college work in forestry.

In announcing these scholarships, T. W. Earle, president of Gair Woodlands Corporation said: "We are pleased to offer, through these scholarships, assistance toward the study of forestry as a profession to two outstanding high school graduates, one from northeastern Florida and one from southeastern Georgia or South Carolina. It is our hope to attract larger numbers of capable high school seniors from our local communities to enter the profession of forestry."

Government

J. J. Byrne to Head Products Research

James J. Byrne has been appointed to the position of chief of the Division of Forest Products Research in the Washington Office of the Forest Service. He will succeed Mr. George W. Trayer who retired on January 31 of this year.

Mr. Byrne, who has been supervising general engineer for the California Region of the Forest Service since 1947, graduated from Montana State College with a BS degree in 1929. He received his Masters Degree in 1931 at the Massachusetts Institute of Technology and entered the Forest Service in 1933.

In his new position Mr. Byrne will oversee the work of the Forest Service in the field of wood and other forest products research including the work of the Forest Products Laboratory at Madison, Wis.

Pioneer Forester Retires

Guy M. Brandborg retired as supervisor of the Bitterroot Forest, Hamilton, Mont., on March 31.

Appointed as forest guard in 1915, Mr. Brandborg progressed through the positions of forest ranger and deputy supervisor on the Helena Forest. He spent a year in the Army during World War I. In 1924, he transferred to the Nezperce Forest in central Idaho where he remained until 1935 as assistant supervisor. By promotion in 1935, he became supervisor of the Bitterroot National Forest.

Forest Research Center Established in Berea, Kentucky

The U. S. Forest Service has recently established a research center in eastern Kentucky. Called the Berea Forest Research Center, it is one of five such centers operated by the Central States Forest Experiment Station, Columbus.

A research program will be developed with major emphasis on forest management. The work will be carried on in cooperation with Berea College, the University of Kentucky, and other public and private agencies.

Malcolm J. Williamson will head up the work. He has spent the last two years as a photo-interpretation specialist in the Forest Service, Washington office. Prior to this he spent 7 years with the Wisconsin Department of Conservation.

F. Bryan Clark, who has been with the research center in Columbia, Missouri, has been assigned to assist Williamson.

Forest Service Revises Timber Sale Contracts

The Forest Service will start using a completely revised timber sale contract form for all but small sales on July 1, 1955. The new form will be in full use by January 1, 1956.

(Continued on page 396)

Model D widening, ditching and grading six miles of road up to Bill's Butte Fire Lookout Tower. Grader is owned jointly by Oregon Dept. of Forestry and Coos County Forest Protective Assn.

model D proves itself able, versatile grader for the woods

The many Allis-Chalmers Model D Graders in forestry and logging service have proved again and again that they have the power and capacity for outstanding service.

Now, for even greater performance ability, power for the Model D has been boosted to 50 brake hp. Also, leaning front wheels and power circle turn now are available (optional). With these and other big grader features such as tandem drive, ROLL-AWAY Moldboard, tubular frame and hydraulic blade lift — the Model D's original cost still is but one-third that of a large grader. Operating costs are low, too.

Let your Allis-Chalmers dealer demonstrate what the Model D can do for you.

ROLL-AWAY is an Allis-Chalmers trademark.

Repairing washed out roads with a Model D to speed travel of logging trucks to mill. Grader is equipped with rear-end loader, and in winter with snowplow, to handle complete maintenance of more than twenty miles of road for Luke and Carlson, Amasa, Michigan.

Interchangeable V or blade-type plows, hydraulically controlled, are available for the Model D. Blade also handles light dozing.

This Model D handles loading as well as road maintenance on school forest for Oregon State University, School of Forestry.

With ⅝ cu. yd. rear-mounted, hydraulically controlled bucket, the Model D easily loads any material to trucks, maintains stockpiles.

50 brake hp.—8,800 lb. (bare)—
4 speeds to 25.6 mph., reverse 3.3 mph.

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Position Available

Experienced Nurseryman

Eastern forest tree nursery requires middle-aged man with small family. Prefer mail order experience. Write full qualifications. Include small photo. Good starting salary and modern home to qualified man. Personal interview will be arranged.

Box A, Journal of Forestry, Mills Building. Washington 6, D. C.

Forestry Employment

S.A.F. members are privileged to insert one 60-word advertisement in this column without charge. Forest industries desiring to employ foresters may insert advertisements at the rate of $4 per column inch. Copy must be received by the end of this month for an advertisement to appear in the issue after next.

Obviously, the Society cannot assume responsibility beyond making it possible for prospective employee and employer to enter into negotiations.

NOTICE TO INDUSTRY

Personnel Placement

A service for industrial firms, foresters, and timbermen—to find the best qualified man for the job. List your openings in forestry and allied fields with me. I can supply information on qualified men. Inquiries handled confidentially.

• • •

Foresters send me data on your training and qualifications. Records are confidential. I maintain industry contacts and can advise you on job openings. No fee required unless position is accepted.

Keith Cranston, *Forestry Consultant*
LELAND, MISSISSIPPI

In drawing up the new form timber management officers were assisted by representatives of the timber associations and of forest industries which buy national forest timber. Timber buyers and the Forest Service have long recognized the inadequacies of the old timber sale contract which had been repeatedly amended since it was first written, to keep pace with the changing times.

The new contract eliminates the fire fighting previously required of a purchaser (without reimbursement) for forest fires within or near the sale area regardless of cause, although he is still responsible for suppression costs of fires caused negligently by his operation. His liability for suppression costs on fires in the sale area caused by his operation, but not caused by negligence, will be spelled out in the sample contract for each sale so purchasers will know the terms before bidding. The contract also provides that the purchaser be reimbursed by the Forest Service at its prevailing rates for suppression of fires on the sale area not caused by his operation.

Other changes in the sales contract include provision for extension in the termination date on request of the purchaser when not contrary to the interests of the government; also, the termination date may be adjusted to compensate for operating days lost because of abnormal occurrences beyond the control of the purchaser.

Earl E. Smith to Peru

Dr. Earl E. Smith has been appointed to the position of forester and botanist with the Foreign Operations Administration for assignment with the United States Operations Mission to Peru. This is a new position created to develop programs in the fields of forestry and economic botany, particularly for more adequate industrial uses for native forests and forest products in the Peruvian rain forest, and to work with the Peruvian Ministry of Agriculture on reforestation projects in the rain forest and in the mountains.

Dr. Smith was graduated from the University of West Virginia in 1948 with the B.S.F. degree. He took graduate work at Harvard University, receiving the M.F. degree in 1950 and the Ph.D. degree in 1953.

During 1951 and 1952, Dr. Smith traveled throughout Cuba to study the forest resources of the island. The study resulted in the publication, in 1954, of the report *The Forests of Cuba*.

Since 1953, he had been with the Section of Plant Introduction of the U. S. Department of Agriculture as a plant explorer, and has traveled extensively in Chile, Bolivia, Peru, Pakistan, Afghanistan, and Iran.

Positions Wanted

Forester, 31, (B.S.F., 1949; M.F., June 1955) interested in working in management section of industrial timberlands department. Experience: 5 years in forest management, including CFI. Veteran, married; 2 children.
Box N, Journal of Forestry, Mills Building. Washington 6, D. C.

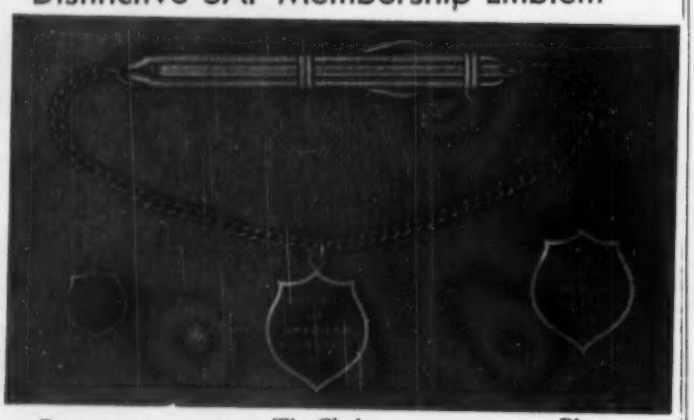
Forester, M.F. 1949. Married, two children. Experience in cooperative forest management, fire control, and forestry educational work. Now employed in Southeast by private corporation in pulpwood production. Desire work requiring minimum or localized traveling in forest management with private individual or corporation.
Box O, Journal of Forestry, Mills Building. Washington 6, D. C.

Graduate forester, age 31, married, one child. Six years excellent background experience in pine pulpwood management and production. Desires responsibility in logging, procurement, or utilization. Would consider partnership arrangement in small active forestry, logging, or wood utilization enterprise.
Box Q, Journal of Forestry, Mills Building. Washington 6, D. C.

Forester, 26, B.S.F. Univ. of Florida, 1949; married; currently employed in wood procurement for pulpwood concern; experienced in cruising, marking, and land surveying; veteran reserve artillery officer. Desires position in field work, in Southeastern United States, with minimum of travel. Excellent references.
Box R, Journal of Forestry, Mills Building. Washington 6, D. C.

Forester, 33, B.S.F., N. C. State, 1950. Married, one child. Experience 4 years woods work in cruising, traversing, mapping, scaling, marking, planting. Currently employed in Northeast. Desires change to slightly warmer climate in work emphasizing management, appraisal, and photogrammetry.
Box S, Journal of Forestry, Mills Building. Washington 6, D. C.

Distinctive SAF Membership Emblem



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THE EMBLEMS pictured above in actual size are 10K gold, with gold letters on a dark green background surrounded by a gold border. All grades of members are eligible to wear these emblems. Order the style you prefer from:

SOCIETY OF AMERICAN FORESTERS
425 Mills Bldg., 17th St. and Pennsylvania Ave., N. W.
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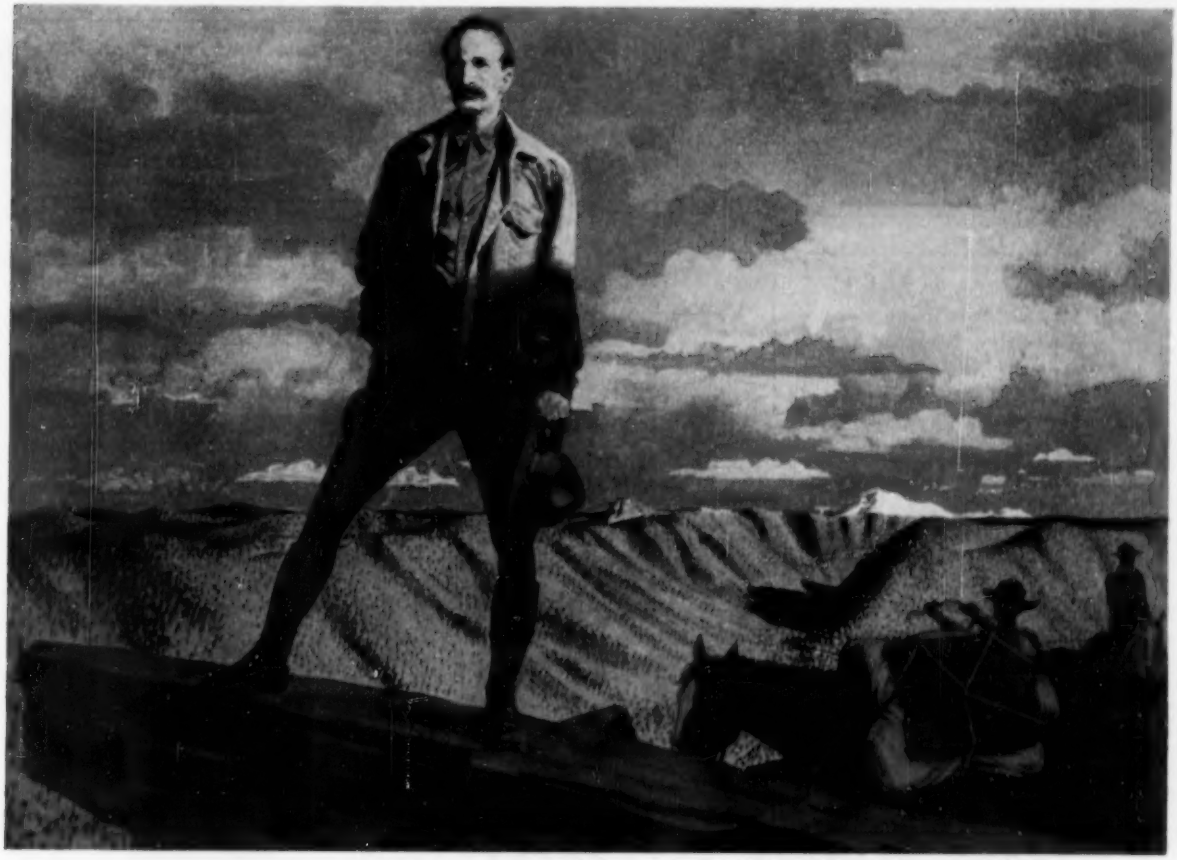
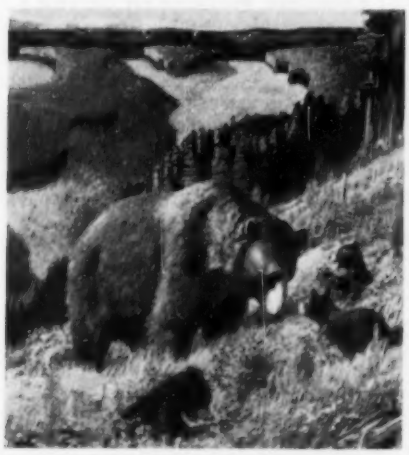


GIFFORD PINCHOT (1865-1946) — A leader in establishment of the U. S. Forest Service 50 years ago, serving as its first chief, 1905-1910. As America's first professional forester, Pinchot helped bring about national awakening to the wisdom of good timberland management. In 1900, he founded Yale School of Forestry

"forest land should be devoted to its most productive use..."

A permanent supply of wood is growing on tree farms. Below, Douglas fir is clear-cut in staggered patches and seed trees are left to reforest the harvested areas.



This year, the U. S. Forest Service celebrates its 50th anniversary. For a half-century, it has been guided by the policy laid down in 1905 by Gifford Pinchot, first chief of the service, and James Wilson, the Secretary of Agriculture. This policy begins: "All national forest land is to be devoted to its most productive use for the permanent good of the whole people..." The policy further provides that the Forest Service apply two basic principles in management of National Forest resources... that of *sustained yield* and *multiple land use.*

The private forest industry voluntarily manages timber as a crop on more than 6,100 commercial tree farms, consisting of about 34 million acres dedicated to continuous wood production. Tree farmers, with the cooperation of Forest Service and other government agencies, also protect their forests against fire, insects and disease. Today, such good forest management is the guarantee of a perpetual wood supply.

All Weyerhaeuser Timber Company forestlands are certified as tree farms by regional timber associations. *For more information on modern industrial forestry, write us at Box A, Tacoma, Washington.*

Weyerhaeuser Timber Company

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A. W. Lindenmuth Joins Rocky Mountain Station

Anson W. Lindenmuth, Jr., specialist in forest fire research, was transferred February 1 to the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

He will have charge of fire research at the Station and will also work closely with fire control men throughout the Rocky Mountain and Southwestern regions.

Forest Service Establishes New Institute of Forest Genetics

A new forest genetics institute in the South has been established at Gulfport, Miss., by the U. S. Forest Service.

A primary purpose of the institute will be to carry on basic research in tree breeding. Findings will apply not only locally but to many sections of the South.

The institute will build up a tree breeding arboretum to provide specimens for the use of tree breeders. It will also serve as a southern information center on forest genetics by maintaining a file of all such projects in the South and elsewhere.

This is the second such institute in the country. The other, at Placerville, Calif., is also under the administration of the Forest Service.

The Southern Institute of Forest Genetics is a branch of the Southern Forest Experiment Station, New Orleans. It is using the buildings and area of the old Gulf Coast Research Center at Gulfport.

Dr. Bereh W. Henry is heading up work at the new institute. He is assisted by Dr. E. B. Snyder, geneticist, Dr. F. F. Jewell, pathologist, and Dr. L. F. Smith and R. M. Allen, silviculturists.

A. A. Wiener to Staff Position

Promotion of Alfred A. Wiener, timber management staff specialist on the Willamette National Forest, to a staff position in the Timber Management Division of the Forest Service regional office in Portland has been announced by Regional Forester J. Herbert Stone.

Education

Industry Service Organized at New York College of Forestry

State University of New York College of Forestry in Syracuse has organized an Industry Service program to meet the demands of the pulp and paper industry for experimentation and tests on a pilot plant scale, according to Dr. E. C. Jahn, associate dean.

The College has for some time maintained a pulp and paper pilot plant for student instruction and research. It is now prepared to undertake a limited number of experiments and test operations for industry and various public agencies.

To facilitate this service, the College has organized a pilot plant program with a special staff headed by Frank W. Lorey. This program is within the Department of Pulp and Paper Technology under the chairmanship of Professor F. W. O'Neil. Negotiations for experiments or tests are carried out between the company or agency and the College of Forestry. The final agreement is made between the company or agency and the Research Foundation of State University of New York. Costs depend upon the equipment and material used and the services rendered.

Dean Dana at Penn State

Samuel T. Dana, dean emeritus of the School of Conservation of Renewable Resources at the University of Michigan, is teaching courses in forest policy and administration at the Pennsylvania State University during the spring semester in the absence of Director M. K. Goddard. Dean Dana is teaching on a consulting basis for a period of one semester and is envolved not only with the teaching of Professor Goddard's courses while he is on leave as secretary of Forests and Waters for Pennsylvania, but is also acting in an advisory capacity to the members of the staff of the Forestry School. The course taught by Dean Dana is being based upon the manuscript of his new book in the field of forestry policy to be published soon by McGraw-Hill Book Co., Inc.

E. W. Johnson Wins Photogrammetric Award

The Bausch and Lomb Photogrammetric Award was presented to Evert W. Johnson, graduate student at the State University College of Forestry in Syracuse, N. Y., at the annual meeting of the American Society of Photogrammetry in Washington, D. C., March 10.

Majoring in forest management at the College, Johnson's award citation reads in part ". . . for originality, ade-

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quacy of comprehension of photogrammetric principles, and excellence of organization and expression as evidenced by a paper submitted to the American Society of Photogrammetry in collegiate competition."

The title of the award winning paper is "The Use of Horizontal Terrestrial Photography in the Inventory of Rick-Piled Pulp Wood Storage Yards."

Johnson is a member of the faculty of Alabama Polytechnic Institute at Auburn, Alabama.

North Carolina Scholarships Established

Ten pulp and paper scholarships for undergraduate students at the North Carolina State College School of Forestry have been established by the newly organized Pulp and Paper Foundation, Inc. The scholarships are worth $600 for a year for four years each. The foundation, which held its organizational meeting early in February, is a group of paper mills, paper converters, equipment manufacturers, equipment and chemical suppliers, and other individuals interested in advancing the college's educational and research work in pulp and paper technology. The school's pulp and paper program has been designed as a regional project by the Southern Regional Education Board.

President of the new foundation is E. J. Gayner, III, president of the Brunswick (Ga.) Pulp and Paper Co. Vice president is Dwight J. Thompson of Champion Paper and Fiber Co., Hamilton, Ohio.

Dean Richard J. Preston of the School of Forestry has announced that bids have been let on the school's new pulp and paper technology laboratory.

Two Minnesota Juniors Win Homelite Scholarships

Two University of Minnesota School of Forestry students have been awarded $250 scholarships by the Homelite Corporation, Port Chester, New York.

They are Michael J. Zelle and Barry G. Peterson, both juniors in forestry. Announcement of the award was made by Frank H. Kaufert, director of the School of Forestry. He says the two were selected on the basis of "their academic aptitude and vocational promise" from all juniors and seniors in forestry.

Students in five other forestry schools have received similar scholarship awards this year from the Homelite Corporation, a manufacturer of chain saws and other light power equipment, and its associated dealers.

R. L. Donahue Making Fertilizer Survey of Greece

Dr. Roy L. Donahue, a soils specialist and chairman of the Department of Agronomy at the University of New Hampshire, is spending three months making a fertilizer survey of Greece. He is working for the Koppers Company of Pittsburgh, Pa., which is under contract from the World Bank, at the request of the Greek Government.

Among the European countries, the Kingdom of Greece today ranks the lowest in crop yields per acre and in fertilizer consumption.

Greece requested the fertilizer survey to justify the construction of a synthetic nitrogen plant to supplement her phosphorus fertilizer production.

Resource Managers' Training School Held in Montana

During the month of February, Montana State University held its tenth annual School of Public Administration for training resource managers. The roster of the school included 19 Forest Service members from western states, four Soil Conservation Service employees, and three members of Montana's state forestry organization. Areas of study covered psychology of personnel, public relations, principles of administration, effective public speech, economics of conservation, community relations, and effective writing.

New Scholarship for Paul Smith's College

Dr. C. L. Buxton, president of Paul Smith's College, Paul Smiths, N. Y., announces the receipt of $100.00 from the Woodsmen's Field Day Committee of the Woodsmen's Club for use as a loan scholarship by forestry students attending Paul Smith's College.

The Woodsmen's Club, through its Field Day Committee sponsors an annual field day for the lumberjacks of the Northeast. This meet will again be held in Tupper Lake, N. Y. in August of 1955. Assisting the Club are the wood-using industries, state and federal agencies and forestry colleges.

Proceeds from the early field days went entirely to the Woodsmen's Club, Cemetery Associations for the burial of lumberjacks, and hospitals. Two years ago the Club purchased movie equipment for use in safety education in the lumber camps. This interest in the education of future woods workers is continued by this scholarship located at Paul Smith's College.

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230 HP (Drawbar)

56,200 LB.

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THE D9...PROVEN IN THE FIELD FOR A YEAR!

Though new, the CAT* D9 is already a veteran. After exhaustive proving tests, several D9s have been tested for over 19,128 hours on the toughest jobs in logging, construction, mining and quarry work. These jobs tested every square inch of this mighty new machine. The word from the field: "By far the best big tractor ever made."

RUGGED—AND EASY TO SERVICE!

From its one-piece welded steering clutch case-frame assembly, to its track shoes hardened by the "Water Quench" process, the D9 is the toughest crawler built. And, it's designed for easy servicing. Oil clutch, torque converter, transmission case and steering clutches can each be removed individually without disturbing other components. Hydraulic track adjusters make service easier, too.

EASY TO OPERATE!

—The independent "live shaft" drive for cable controls makes operation smoother, easier.

—Hydraulic boosters provide power steering *and* braking.

—Adjustable seat, all-around visibility, easy access to all controls make operator's job simpler.

—7-roller track frame improves stability and ride.

—New starting engine has electric starting system and simple single-lever control for easy operation from the seat and insures fast starts in all weather.

All in all, the new D9 sets a new standard of big, money-making, earthmoving performance. Get the full facts about this rugged giant from your Caterpillar Dealer.

FAST FACTS ON THE D9

FIRST TRACK-TYPE TRACTOR WITH TURBOCHARGER! The D9's new Turbocharger is driven by the engine exhaust, utilizing energy which would otherwise be lost. Packs air into engine according to engine *load, not speed;* means more working HP — greater performance.

CHOICE OF TORQUE CONVERTER OR DIRECT DRIVE! Two types of drive are available, the exclusive Caterpillar oil clutch with six-speed (forward and reverse) transmission or a three-stage torque converter with 5:1 torque ratio. The transmission used with the torque converter has three speeds forward, two reverse. This option enables you to match the drive you want to your job requirements.

COMPLETELY NEW 286-HP ENGINE! In addition to the Turbocharger, the powerful new D9 Engine features a 6¼" bore and 8" stroke and runs at 1200 r.p.m. Long life and dependability are promoted by stationary oil jet piston cooling; short, rigid valve push rods give smooth, accurate valve action; "Hi-Electro" hardened gear at rear of crankshaft drives timing gears and accessories; other advanced features.

WIDE RANGE OF OPERATING SPEEDS!

Torque converter: 3 speeds forward, 0 to 4.1 m.p.h., 0 to 5.7 m.p.h., 0 to 7.8 m.p.h. • 2 speeds reverse, 0 to 4.1 m.p.h., 0 to 7.8 m.p.h.

Direct drive: 6 speeds forward, 1.6, 2.1, 2.9, 3.9, 5.0, 6.8 m.p.h. 6 speeds reverse, same

CONSTANT-POWER DRIVE FOR REAR-MOUNTED EQUIPMENT! You always have power for cable controls, direct from the engine's rear power take-off. This makes cable control operation completely independent of flywheel clutch or torque converter, boosts operating efficiency.

EQUIPMENT: New Caterpillar-built 'Dozers for the D9: the No. 9S Bulldozer, modified straight blade; the No. 9A Bulldozer, angling blade. New Caterpillar-built Cable Controls: the No. 29 rear-mounted, double drum; the No. 30 front-mounted, single drum.

SPECIFICATIONS: Length 17' 10¾", width 9' 11¼", height 8' 9", gauge 90", approx. wt. 54,000 lb. dry — 56,200 lb. operating.

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And whether it's the 22 pound Model 17 with 3.5 horsepower, or the 30 pound, 5.5 horsepower Model 5-30 — a Homelite slices through big stuff in seconds . . . in *any* position . . . without carburetor adjustment or loss of power.

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